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NOTE.

The authors of the several papers contained in this volume are themselves accountable for all the statements and reasonings which they have offered. In these particulars the Society must not be considered as in any way responsible.

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MEMOIRS.

PROCEEDINGS.

I. The Palæontology of the Manx Slates of the Isle of Man.

By Herbert Bolton, F.R.S.E.

Read April 5th. Received April 19th, 1898.

(With additions by G. W. Lamplugh, F.G.S., Jan. 5th, 1899.)

The series of slates and grits which make up the greater part of the Isle of Man have long been considered as the equivalents of the Skiddaw slates series of the English Lake district.

Their claims to be so considered have hardly been satisfactorily proved.

Prof. Henslow,* who described the geology of the island in 1821, classified the series now called Skiddaw slates according to lithological character, dividing them into a quartzose series, clay-slates, mica-slates and grey-wackes.

Cumming† regarded them as lower silurian, whilst Messrs. Grindley‡ and Taylor§ wrote of the "cambrian" strata of the Isle of Man.

In no case did the authors furnish any evidence, beyond that of general resemblance, by which the series could be correlated with the Skiddaw series of the Lake district, and the Cambrian series of North Wales.

* "A Supplementary Notice of the Isle of Man." *Trans. Geol. Soc.*, Ser. I., Vol. v., 1821.

† *The Isle of Man, Its History, &c.* London: Van Voorst, 1848.

‡ "Geology of the Isle of Man." *Geologist*, 1862, pp. 171—183.

§ "Supposed Imprints in the Lower Cambrian Beds of the Isle of Man." *Geologist*, Vol. v., 1862, p. 321.

May 4th, 1899.

Probably the paper by Profs. Harkness and Nicholson* contributed most to the recognition of the Manx series as equivalents of the Skiddaw slates. By these writers a general resemblance of rock structure was traced between the two series, and also the occurrence in both of *Palæochorda major* was noted. One point upon which Profs. Harkness and Nicholson laid considerable stress was the apparent similarity of dip and strike in the two regions.

Mr. Lamplugh's late researches† would seem to show, however, that this dip and strike is but a dominant structure due to complex folding and cleavage, and that the true dip and strike still remains to be determined.

Mr. G. W. Lamplugh writes me—"This argument requires modification if, as is probable, the Lake district dips are also more or less mere 'dominant structures.' The fact of this structure coinciding in the two areas is of some importance in the correlation."

The ashes and porphyries of most writers have not been recognised by Mr. Lamplugh, nor has he found evidence of contemporaneous volcanic activity [, except in one very limited and obscure exposure, near Dalby, on the western side of the island (*vid.* Annual Report of the Geological Survey for 1897, p. 70).—G. W. L.].

The Rev J. Clifton Ward, who visited the island in 1879‡ to determine the relationship between the two series, was no more successful than his predecessors. He was not able to recognise any volcanic series, nor could he find that the slates showed any of those divisions which he recognised in the Lake district. He still regarded them as Skiddaw slates, but looked for a right

* "The Lower Silurian Rocks of the Isle of Man." *Quart. Journ. Geol. Soc.*, Vol. xxii., 1866.

† "The Crush Conglomerates of the Isle of Man." *Quart. Journ. Geol. Soc.*, Vol. li., 1895, p. 565.

‡ Notes on the Geology of the Isle of Man. *Geol. Mag.*, 1880.

interpretation of them as being dependent upon a fuller knowledge of the Lake district rocks. Mr. Lamplugh's researches, already alluded to, seem to indicate that a close comparison between the two areas by the aid of stratigraphy is well nigh impossible.

Reviewing all the work upon the Isle of Man slates, it would appear that a general unanimity exists that they represent the same phase of sedimentation as the Skiddaw slates of the Lake district, but whether they are wholly or in part contemporaneous, or whether they are capable of the same divisions is a matter upon which no convincing evidence has been produced. [It has also been shown* by Mr. J. E. Marr that, under the term "Skiddaw slates," there has been included, on the mainland, a series of rocks having a wide stratigraphical range, so that even if the general correlation be accepted, the exact age of the Manx slates is not thereby settled. In the map of the island recently published by the Geological Survey, the term "Skiddaw slates" is dropped, and the name "Manx slate series" substituted, the age being given as doubtfully Cambrian.—G. W. L.]

The fossils found have been very few and of a somewhat problematic character, and the most which could hitherto be said of them was that they are traces of a fauna which had much in common with that of some portion of the Skiddaw slates.

This paper is an attempt to review in detail the palæontological evidence of previous observers, and to present additional facts upon the fauna of the Manx slates.

The Rev. J. G. Cumming and others had in various papers alluded to the occurrence of fucoids or "corallines" of an indeterminable character, but it was not until 1862

* *Geol. Mag.*, 1894, Dec. 4, vol. i., p. 122.

that any attempt was made to describe the supposed fossils.

In that year Mr. J. Taylor* described certain supposed imprints in the slates of Dalby. These imprints were said to resemble the dotted outline of the *Protichnites* figured in Owen's *Palæontology*.

Mr. Mackie, Editor of the *Geologist*, thought that the impressions looked more like portions of gigantic *Lingulæ* or some fibrous shell. Mr. Salter denied their organic origin altogether, and Mr. Lamplugh informs me that the impressions were probably the hollows left by the decay of the slightly calcareous nodules, which occur rather abundantly in some localities.

The fibrous structure mentioned by Mr. Mackie, may have been "slicken-siding" developed in the slate in immediate contact with the nodules, or the strain-slip cleavages which are present almost everywhere.

In 1863, a paper was read by Mr. Taylor† before the Manchester Geological Society, in which he mentioned the discovery by Mr. Thos. Grindley of a fucoid, and also avers that behind the Castle Mona Hotel, he himself discovered both fucoids and the tracks and castings of worms.

At Mount Craig he found the remnant of an *Orthoceras*, the specimen showing the chambers and also the gradual tapering of the body of the shell.

In the absence of either the specimen or of any figure, neither of which seem to have been exhibited, very little reliance can be placed upon the description.

It is not unlikely that it refers to some partially weathered out worm-casting, or to thin intersecting mineral veins, which in these rocks often simulate chambered organisms. The same paper mentions that

* *Loc. cit. ante.*

† "Cambrian Strata of the Isle of Man." *Trans. Manch. Geol. Soc.*, Vol. iv., 1863, p. 285.

thin veins of what was supposed to be anthracite were met with in the metaliferous lodes at Laxey, and a lode of impure graphite at Ballacraine. [Sir W. W. Smyth also mentions the Laxey anthracite in his list of Manx minerals (*Trans. Isle of Man Nat. Hist. Soc.*, vol. i., p. 143) as "a 3-inch band on the east wall of Laxey-lode, 100 fathom level, south of engine shaft, very pyritous."—G. W. L.]

Profs. Harkness and Nicholson* in 1866 recorded the finding of *Palæochorda major.*

Mr. E. W. Binney† next took up the work in 1877, and published figures and descriptions of worm tracks which he named *Nemerites monensis* and *Neretites monensis* respectively. Worm-burrows (*Scolites*) were also mentioned and certain oval structures which he supposed had some faint resemblance to *Lingulæ*, but which Mr. Lamplugh thinks may have been the cross-sections of worm-casts.

Whatever these latter may have been, one was somewhat doubtfully referred by Binney to *Lingulella davisii.*

In the succeeding year Binney‡ figured and described the supposed fucoid found in the glacial drift at Laxey, and from a superficial resemblance of the specimen to *Psilophyton cornutum* of Lesquereux, he was led to name it *Psilophyton monense.* In a later communication, Binney§ states that Dr. Dawson was of opinion that the supposed plant more nearly resembled *Buthotrephis harknessi* of Nicholson; it is well to bear in mind,

* *Loc. cit. ante.*

† "A Notice of some Organic Remains from the Schists of the Isle of Man." *Proc. Manch. Lit. & Phil. Soc.*, Vol. xvi., 1878, p. 102.

‡ "Notice of a Fossil Plant found at Laxey, in the Isle of Man." *Proc. Manch. Lit. and Phil. Soc.*, Vol. xvii., 1878, p. 85, and *Manch. Memoirs*, 3rd Series, Vol. vi., 1879, p. 214.

§ "Remarks on a Fossil Plant found at Laxey, in the Isle of Man." *Proc. Manch. Lit. and Phil. Soc.*, Vol. xviii., 1879, p. 19.

however, that Dr. Dawson was guided in his determination by the description and figure, and not by an examination of the specimen.

In 1892 the intaglio cast of a trilobite was found by the writer* in a crush-conglomerate at Ballastowell, near Ramsey, and in 1893† a few other fossils (*Dictyonema* and *Dendrograptus*) were added from the slates of Cronk Sumark, near Sulby Glen station.

From the foregoing it will be apparent that the suite of fossils recorded from the Manx slates are of a doubtful character, without much support from positive evidence, and requiring further investigation.

If we consider, in the first place, the supposed plant remains, we find that all the earlier workers made allusion to "fucoids," but that Binney was the only one to attempt a description of what he saw.

Prolonged research amongst the slates by many recent workers has revealed no trace of true fucoids, and, as we shall see later, the supposed fucoids were, in all probability, the casts and tracks of *Palæochorda.* In the absence of descriptions, figures or specimens, we are forced to reject the supposed fucoidal structures of Taylor, Grindley and others.

Psilophyton monense of Binney calls for more attention. It was described as follows: "The stem is thick, dichotomous, divisions variable in distance, the terminal ones short, pointed, nearly equal in size and length, surface nearly smooth. The branches in the lower part are thick comparatively to their length. The surface of the stem appears to be smooth, and affords no evidence of striæ or

* "On the Occurrence of a Trilobite in the Skiddaw Slate of the Isle of Man." *Geol. Mag.*, Dec., 30, Vol. x., 1893, p. 29.

† "Observations on the Skiddaw Slates of the Isle of Man." *Brit. Assoc. Rep.*, *Notts*, 1893.

scales." A woodcut accompanies the description, but is too coarsely drawn to illustrate anything except that there is no dichotomy.

The specimen was said to run nearly at right angles to the bedding (? cleavage), and that it lay upon the surface of a boulder taken from the glacial drift.

In this case, as with previous writers, there is a lack of positive evidence, but an attempt has at least been made to describe the supposed fucoid intelligently. It is most unfortunate that the woodcut does not increase, but rather nullifies, the value of the description.

The species cannot be accepted as a good one, nor is there evidence to show that the boulder was derived from the slates of the island. There is no certain knowledge of plant remains.

Animal remains are of a less uncertain character than the fucoids, but are few in number and species and far from satisfactory.

We have already seen that Profs. Harkness and Nicholson recorded *Palæochorda;* E. W. Binney figured and described *Nemertites monensis* and *Neretites monensis*, and added the Cambrian brachiopod, *Lingulella davisii.*

To these must now be added a few fragments of Hydrozoa, and the impression of an obscure trilobite [, but they are evidently very rare as later searches have, up to the present, been unsuccessful.—G. W. L.].

In the north quarry from which the specimens were obtained, the slates are strongly cleaved and break up readily into irregular shuttle-like masses. The cleavage planes form an acute angle with the bedding, which is frequently indicated by bands of colour. The slates are much iron-stained, and in close association with grits and the remarkable "crush-conglomerates" described by Mr. Lamplugh.

Prolonged search resulted in the discovery of two small splintery masses of slate, each bearing *Dictyonema* and *Dendrograptus* in association. The former genus was most numerous, fragments of nearly a dozen individuals being present; of the latter genus only two specimens were clearly distinguishable.

Dictyonema (Dictyograptus) sociale Salter. (*Plate* I, *figs.* I, 2.)

Remains of not less than eight individuals were found lying in close apposition upon the surfaces of two narrow splintery slabs of slate.

Two individuals are fairly well defined, and show clearly the bifurcation of the branches. Each consists of about six main branches which bifurcate twice, and are arranged parallel to one another in the close radiate order so characteristic of the species.

Transverse filaments, or dissepiments, are not well defined, except in the case of the tertiary branchings where they are very oblique.

On one slab, the individuals lie without any order as if drifted there; on the other, three individuals lie at equal distances apart and pointing in the same direction, and are at right angles to a specimen of *Dendrograptus flexuosus*.

A direct comparison of the Isle of Man specimens with well-defined forms of *D. sociale* obtained from Borth, Tremadoc, Wales, shows a close similarity, extending even to the character of the rock, and the abundant presence of iron-staining in both.

Dendrograptus flexuosus Hall. (*Plate* I, *figs.* I, 2.)

Fragments of three individuals of this species are associated with those of *Dictyonema sociale* already described. The frond expands rapidly and consists of short flexuous branches which bifurcate regularly and at

equal distances. As in the type, the first branchings are placed at an acute angle with each other, the last ones being fairly parallel. The agreement of these specimens with the description given of the species by Hopkinson and Lapworth* is very close. They are too badly preserved to show the hydrothecæ but the regular bifurcation, the flexuous character of the branches and the close correspondence of size are distinctive.

Worm-castings, tracks and burrows.

Under this head must be placed the *Palæochorda major* and *P. minor* McCoy, once regarded as fucoids.

Palæochorda major was recognised in the Manx slates by Profs. Harkness and Nicholson, and considered by them of considerable value in correlating the latter with the Skiddaw slates of the Lake district.

If, as we may suppose, the earlier workers considered the species as a fucoid, it is easy to understand the frequency of the finding of "fucoids" by them.

Worm-castings, tracks and burrows are fairly common in many of the Manx slates, and certain grits are almost composed of them. Especially is this the case in the cliffs south of Porth Mooar.

Palæochorda minor McCoy. (*Plate* 1, *figs.* 3, 4, 5.)

The smallest worm-castings the writer has seen are in a series collected by Mr. G. W. Lamplugh, and kindly placed at his disposal by the Director General of the Geological Survey.

The castings are usually in the form of long straight semi-cylindrical rods, rarely occurring in clusters or showing much trace of coiling. They consist of grains of sand hardened into a fine grit.

* "Descriptions of the Graptolites of the Arenig and Llandeilo Rocks of St. Davids." *Quart. Journ. Geol. Soc.*, Vol. xxxi., 1875, p. 662.

To this species we would also refer Mr. Binney's *Nemerites monensis.* The latter was stated to occur in blue laminated slate at Oakhill, Braddan, and was found during the cutting of the railway from Douglas to Castletown. It was described as occurring in the form of a simple loop, twelve inches long and one-eighth of an inch in diameter. Mr. Binney's figure agrees very closely with that of *P. minor* figured by McCoy.

Palæochorda major McCoy. (*Plate* 1, *figs.* 6, 7.)

Worm-castings, larger than those of *P. minor*, occur abundantly in many of the slaty grits ; they vary somewhat in diameter, from three to four lines being a fair average. Not infrequently the castings lie in clusters, but show few traces of coiling.

The fine cleaved slates have yielded few castings, but faint shallow tracks are not rare. They are usually very long, and average two lines in diameter.

Neretites monensis of Binney was a worm-track found in a blue slate. * The dimensions are not given, but the worm-track was described as meandering and consisting of about one hundred segments with traces of feet and cirri, and terminating in an oval-shaped head.

An examination of Binney's figure shows that the segments cross the worm-casting obliquely, and that they are in line with a shear structure developed in the slate. Indeed, the shearing is shown by the artist to join with the segments, so that the latter appear as slight dislocations of the casting. The segments are clearly no part of the worm-track, but have been induced by shearing, a fact still further brought out in the figure by the dragging out of one side of the casting along its upper loop.

* Mr. Lamplugh writes me that this blue slate would be in a flaggy-sandy series—probably a thin parting in a quarry at Mary Veg, Santon.

The "oval-shaped head" is figured as a depression against which the cast abruptly stops. It looks like, and probably is, a worm-burrow.

Chondrites informis McCoy. (*Plate* 1, *figs.* 8, 9, 10.)

Among the worm-casts collected by Mr. Lamplugh in the course of his examination of the slates there is a series differing from any hitherto described, and of larger size. By his kindness I have been enabled to examine them.

The castings vary in size from a diameter of three to seven lines. They are composed of rather coarse grains of sand, which are partially compacted together. The matrix upon which they lie, often in high relief, is a slaty grit. A few of the castings are solitary, and when well preserved show a gradual reduction in diameter towards one extremity. More often they occur in clusters, lying parallel to or overlapping one another. Where they overlap, subsequent crushing has obliterated, to some extent, the lines of apposition between contiguous castings, so that they appear at first sight as branching or forked structures.

Their resemblance to *Chondrites informis* McCoy, is so very close that we include them in this species.

Crustacea are represented by the impression of a single obscure trilobite. Doubt* has been expressed as to this impression being that of a trilobite, but the balance of opinion is strongly in its favour.

Æglina or *Asaphus*. (*Plate* 1, *fig.* 12.)

The trilobite impression found at Ballastowell has been already referred to. It will be sufficient if we now give a diagnosis, already published in the *Geological Magazine.*

* G. W. Lamplugh. "The Crush Conglomerates of the Isle of Man." *Quart. Journ. Geol. Soc.*, Vol. li., 1895, p. 578.

IMPRESSION OF BODY AND PYGIDIUM.

"Thorax of six rings; axis convex and of uniform width; body rings narrow and well marked off from one another. Pleuræ very broad, twice the width of the axis; grooves deep, broadening towards the extremities, and disappearing a short distance from the axis; extremities directed backwards. Pygidium a little more than half the length of the thorax; width double the length; axis flattened, convex, and ending bluntly in the middle of the pygidium.

"*Observations.*—From the presence of six thoracic rings, grooved pleuræ, and semi-circular smooth pygidium with feeble axis; the writer was inclined to class the specimen as an *Æglina*, but Dr. Henry Woodward has kindly pointed out that it differs from *Æglina* in the sides of the axis being parallel along their whole length, and in being convex, whereas in the former the axis diminishes in breadth from before backwards, and is flattened.

"From a careful comparison of the specimen with others from the Cambrian of North Wales, Dr. Woodward is of opinion that it might with equal propriety be placed in the genus *Asaphus* as *Æglina*. Unfortunately the specimen is too distorted and fragmentary to settle the point."

Brachiopods are not known with certainty, for though the oval depressions described as footprints by Grindley and Taylor were afterwards doubtfully referred to as the casts and trails of bivalves and the impressions of *Lingula*, neither figures, specimens, nor facts which can be verified, are available to justify their retention.

The figures and description of the supposed *Lingulella davisii* published by Binney might serve equally well as figures and description of nodule masses still *in situ* in the slates, and wholly inorganic in origin.

The casts and trails of Grindley and Taylor can be similarly duplicated by hollows left by the weathering out of nodules, and by worm-tracks.

If we summarise the foregoing, it will appear that a

critical examination of the published results of geological workers reveals a remarkable paucity of fossils, and the existence of much doubt as to the true position and nature of what few have been found.

It is evident also that the claims of the Manx slates to be considered as equivalents of some parts of the Skiddaw slates of the Lake district rests largely upon the correct identification of not more than half a dozen species. [The absence of the numerous Arenig species which form a well-marked fauna in one part of the Skiddaw rocks of the Lake district, if it be not explained by the obliteration of the fossils by earth movement, seems to indicate that the upper beds of the Skiddaw series may not be represented by any part of the Manx slates.—G. W. L.]

Evidence gained from lithological structure and stratigraphical sequence is not yet available, for the true structure of the area does not yet seem to have been unravelled.

Conclusions.

The association of such forms as those enumerated in this paper seem to indicate that the stratigraphical position of the slates will be found ultimately to be either amongst the uppermost beds of the Cambrian system, or in the Arenig Series.

It is a pleasing duty to acknowledge the great debt I owe to Mr. G. W. Lamplugh of the Geological Survey as well in the field as by the loan of specimens, and by constant advice and assistance.

EXPLANATION OF PLATE I.

Figs. 1, 2. *Dictyonema* (*Dictyograptus*) *sociale* Salter, associated with *Dendrograptus flexuosus* Hall; in Fig. 1 the latter species occupies the middle of the slab, and is disposed at right angles to the former.

Horizon and locality: Manx Slates; Cronk Sumark, near Sulby Glen. Collected by the author.

Manchester Museum Collections.

Figs. 3, 4. *Palæochorda minor* McCoy.

Horizon and locality: Lonan Flags; cliff south-west of Onchan Harbour, near Douglas Collected by Mr. G. W. Lamplugh, F.G.S.

Geological Survey Collections.

Fig. 5. *Palæochorda minor* McCoy.

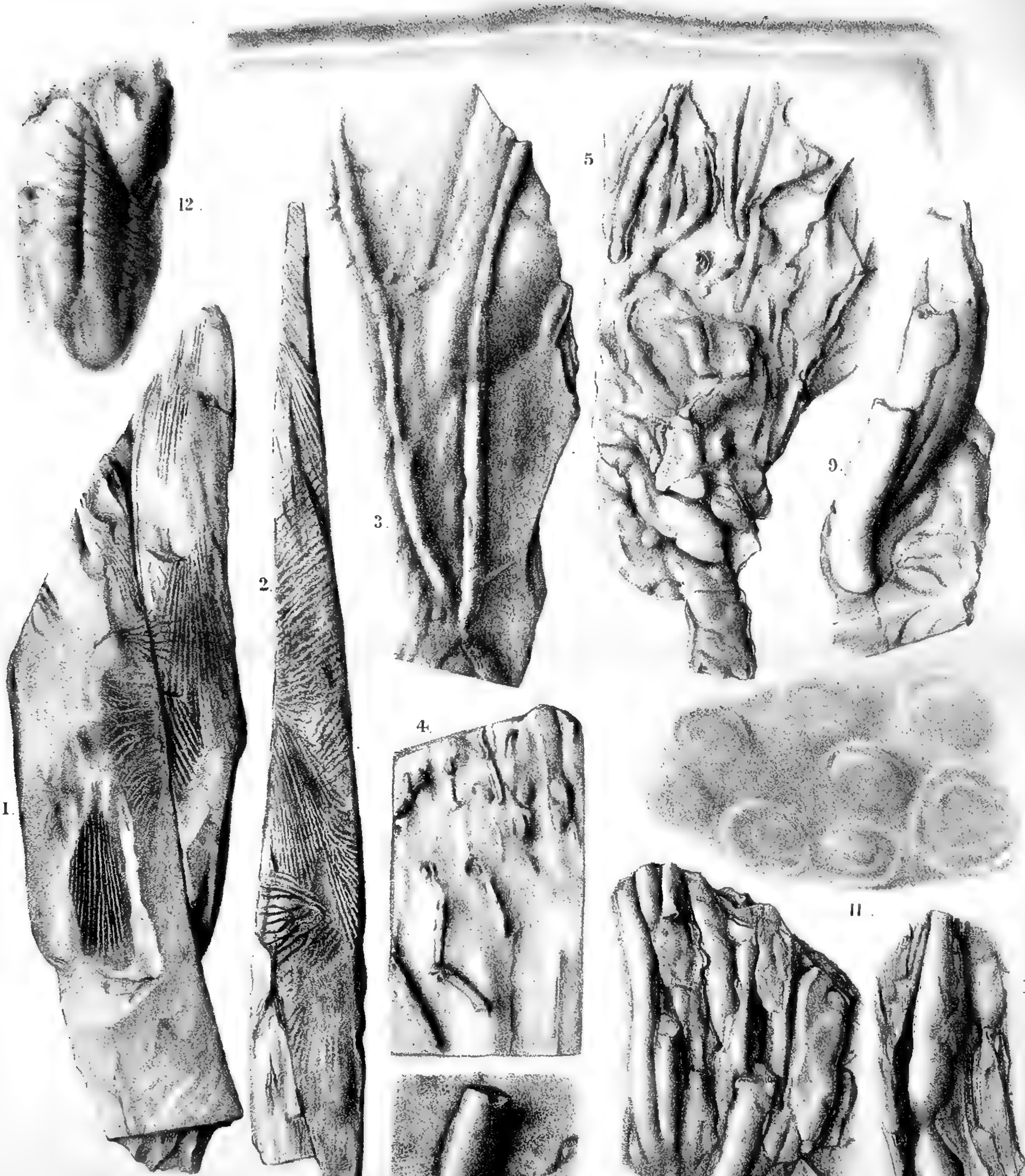
Horizon and locality: Lonan Flags; north side of Martha Gullet, Langness. Collected by Mr. G. W. Lamplugh, F.G.S.

Geographical Survey Collections, No. L81.

Fig. 6. *Palæochorda major* McCoy. Worm-track only upon surface of a fine cleaved slate.

Horizon and locality: Manx slates; quarries on north side of Maughold Head, near Ramsey. Collected by the author.

Manchester Museum Collections.



G. M. Woodward del. et lith.

PALÆONTOLOGY OF THE MANX SLATES.

Mintern Bros. imp London.

Fig. 7. *Palæochorda major* McCoy. A cluster of partially flattened castings.

Horizon and locality: Manx Slates; foreshore 65 yards north of Creg Custane, Langness. Collected by Mr. G. W. Lamplugh, F.G.S.

Geological Survey Collections, No. L79.

Figs. 8, 9, 10. *Chondrites informis* McCoy.

Horizon and locality: Manx Slates; fig. 8, foreshore north of Creg Custane, Langness; fig. 9, north side of Martha Gullet, Langness; fig. 10, south side of Gullet Buigh, Langness. Collected by Mr. G. W. Lamplugh, F.G.S.

Geological Survey Collections, Nos. L72, L82, L113.

Fig. 11. Disc-like markings of unknown (but possibly organic) origin, occurring upon slab of slate.

Horizon and locality: Manx Slates; quarries north side of Maughold Head, near Ramsey. Collected by the author.

Manchester Museum Collections

Fig. 12. *Æglina* or *Asaphus* sp. (?) Enlarged 4 diameters. The drawing has been made from an impression taken in modelling wax of the original intaglio cast.

Horizon and locality: Manx Slates; small quarry at Ballastowell, near Ramsey. Collected by the author.

Manchester Museum Collections.

II. (*a*) Further Research on the Structure of Psaronius, a Tree Fern of the Coal-Measures.

(*b*) On the Leaf-Sheath surrounding the Nodes of some of the Calamites of the Lancashire Coal-Measures.

By JOHN BUTTERWORTH, F.R.M.S.

[*Communicated by James Cosmo Melvill, F.L.S.*]

Received and read October 4th, 1898.

Received in the present form February 10th, 1899.

(*a*) The coal-plant to which I wish to draw your attention is not, in itself, a new plant, but the features exhibited in a specimen I have recently found at Booth Hill, Crompton, and also in one more recently found at the same place by Mr. David Gartside, one of my fellow-workers in this study, are entirely new. The arborescent ferns of the carboniferous period, both of this country and the continent, are at present known under the name of *Psaronius.* Corda, in his "Flora der Vorwelt," 1845, describes several varieties, and the late Professor Williamson, in his seventh memoir, "On the Organisation of the Fossil Plants of the Coal Measures,"* describes a variety which he has named *Psaronius renaultii.* The point raised in this communication is, however, one that may seriously affect present ideas regarding the structure of the arborescent ferns of the coal period. I believe that, up to recently, all ferns have been understood to be of

* *Phil. Trans.*, 1875.

endogenous growth, that is without secondary thickening. Certainly what is known of coal ferns points to this conclusion. I shall, however, presently put on the screen a series of views which I have photographed from the actual sections now lying before you, which will make this matter more clear. The sections referred to above showing *Psaronius renaultii* as Professor Williamson described it, and also the sections of my new form of *Psaronius* I have produced, so that any member may examine them under the microscope. Among the slides above alluded to are a few which I have copied from Corda's work, to show wherein my *Psaronius* differs from both those of Corda and that of Williamson, neither of whom, I believe, hints at the possibility of the Psaronius roots belonging to an exogenous fern, nor was it to be expected, as no example, I believe, has ever been found previous to those I shall show you, to prove that some ferns, at least, show secondary growth, and may merit being placed among exogenous plants. You will see, as we pass the views before you, that all Corda's examples, as well as that of Williamson, are of the endogenous order, the vascular tissue existing in bundles as in the various *Rachioptera*, or in lune-shaped bands as seen in the main axis of *Psaronius.*

In the aerial roots of the last named fern, in many of Corda's examples, the central vascular axis takes the shape of a star, but in my *Psaronius* I shall be able to show you that, in several instances, a second vascular tissue starts off from the above named star-shaped centre, in one case entirely enclosing it in a cylinder of compact secondary vascular tissue of a finer character, while, in other instances, the secondary growth is only just starting from the primary vascular centre.

The roots of my new *Psaronius* are collected in groups,

in the manner typical of the aerial roots of this genus, probably running parallel down the stem. Unfortunately the stem to which my specimen belonged has not been found. One of my preparations passes through twenty-five roots or portions of roots; not all of these show secondary thickening, and it is noticeable that those with secondary increase of tissue lie towards one side of the section, but, from the absence of the stem, it is impossible to say whether these are nearer the stem or further from it.

In size, one can see that the roots showing secondary growth are thicker in diameter than those showing only primary wood, and this increased thickness applies not only to the size of the central cylinder, but to the root as a whole. The roots with secondary thickening are, as a rule, also more irregular in outline; this is, no doubt, due to the difficulty of secondary growth in organs so closely packed together as the roots of *Psaronius*.

One of my sections, cut through about twenty roots with primary structure only, shows that in this condition they are specifically different from *Psaronius renaultii*.

The roots of the latter fern possess five or six rays of wood, generally five, while the roots of my new species possess six, seven or even eight groups of primary xylem, but are most frequently heptarch, *i.e.*, possess seven groups of primary tissue. In *Fig.* 1, there are two roots with primary wood only, one of them possessing seven, the other eight rays of wood, each with a group of protoxylem at its extreme outer end. In other respects these roots agree very closely in their structure with those of *Psaronius renaultii*. The soft phloem masses are generally very badly preserved, their place between the xylem rays being often without any cellular tissue. Around the central cylinder there are generally seen two well-preserved layers of cells, separating the central cylinder from the cortex.

The inner thin-walled cortex is in some roots very well preserved, in others it is entirely disorganised. The thick-walled outer cortex is of course very well preserved, and seems slightly thicker in extent than the same layer in *Psaronius renaultii.* On the outside of this outer cortex numerous multicellular hairs are given off, which form a complex, felted mass of elongated cells between the adjoining roots.

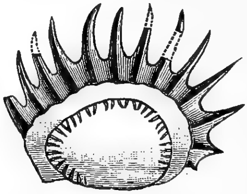
The presence of secondary thickening is distinctive in my new *Psaronius.* It occurs to a varying extent in different roots of my specimen. Sometimes the secondary increase takes place only on one side of the central cylinder, as in *Fig.* 1, (*c*); sometimes the roots increase uniformly in thickness on all sides of the central cylinder, as in *Fig.* 2. In all cases of secondary thickening the primary groups of wood become separated by the formation of secondary wood between the primary rays. This is well seen by comparing, in *Fig.* 1, (*c*), the primary rays without secondary thickening with those rays in connection with which secondary wood has been formed. It is clearly seen, in *Fig.* 2, that this interstitial secondary wood has forced the xylem rays apart. This first-formed portion of the secondary wood is composed of cells which are not so regularly arranged as the later secondary wood beyond the protoxylem groups, which forms, as seen in *Fig.* 2, a continuous cylinder. Here the cells are arranged in rows and present a very typical appearance of cells formed from a secondary meristem. These cells of the secondary wood, where they are cut slightly obliquely, show a scalariform marking similar to that of the primary vessels. Medullary rays, if present, do not show distinctly in the transverse section, and those roots which showed secondary wood were not long enough for longitudinal sections to be cut from them. The secondary phloem too,

cannot be distinctly identified, though a couple of layers of cells, probably constituting the cambium, can be distinguished around the secondary xylem. In *Fig.* 2, it can be seen at some places in contact with the secondary wood, and in other regions widely separated from it. The inner and outer layers of the cortex are both noticeable in such old roots, but on the outside of the outer cortex there are no longer any of the numerous hairs which form so characteristic a covering to the young roots.

Since my communication was read before this Society, I have carefully re-examined all my sections and re-read the published memoirs on *Heterangium tilioides* and *Heterangium griveii*, and, notwithstanding that my conclusions that the new *Psaronius* which I have discovered is the root of *H. tilioides* are doubted, I am still of opinion that these Psaronius roots belong to a form which has close affinities with *H. tilioides*, and thus represents a link between the *Psaronius* of Corda and *Heterangium* with its extensive secondary thickening. Until, however, the stem belonging to my new root is discovered, I wish it to be known as *Psaronius cromptonensis*, in recognition of the richness of the locality of Crompton in coal-measure plants.

I have to acknowledge my indebtedness to the authorities of Owens College for placing several sections of *Heterangium* at my service for examination during this investigation, and have also to thank Prof. F. E. Weiss for his kind help in these labours.

(*b*) Although the specimen which I have found of the leaf-sheath surrounding the node of a Calamite is not perfect, still it shows considerable detail of the internal structure of the Calamite at the node, as well as some of the structure at the base of the sheath, while the specimen found by Mr. Parker, of Rochdale, though only a cast in coal shale, shows considerable detail of the outer part of the sheath. The wood-cut shows the leaf-sheath as seen



in Mr. Parker's specimen, the drawing being the actual size of the fossil. It will be seen that the sheath extends about one-third of the total length of the leaves. The leaf-sheath is separated from the vascular cylinder by a band of cortical tissue of which the structure cannot be made out. In the central cylinder, however, the vascular bundles can be seen branching, and thus indicating that the fossil is split through the node, where the leaf-sheath must have been inserted. The insertion of this leaf-sheath at the node of the stem is also very clearly seen in the sections cut through the fragment which I have found myself.

A leaf-sheath in a Calamite is figured in Seward's Fossil Plants, Vol. I., p. 260. It, however, is less distinct, and differs considerably in its extent and proportions from that figured in this paper.

EXPLANATION OF PLATE 2.

Fig. 1. *Photograph of a portion of a section cut through the roots of Psaronius cromptonensis, showing two roots (a) and (b) without secondary thickening, (c) a root with secondary growth on one side.*

Fig. 2. *Photograph of the central cylinder of a root of Psaronius cromptonensis with a complete ring of secondary wood.*

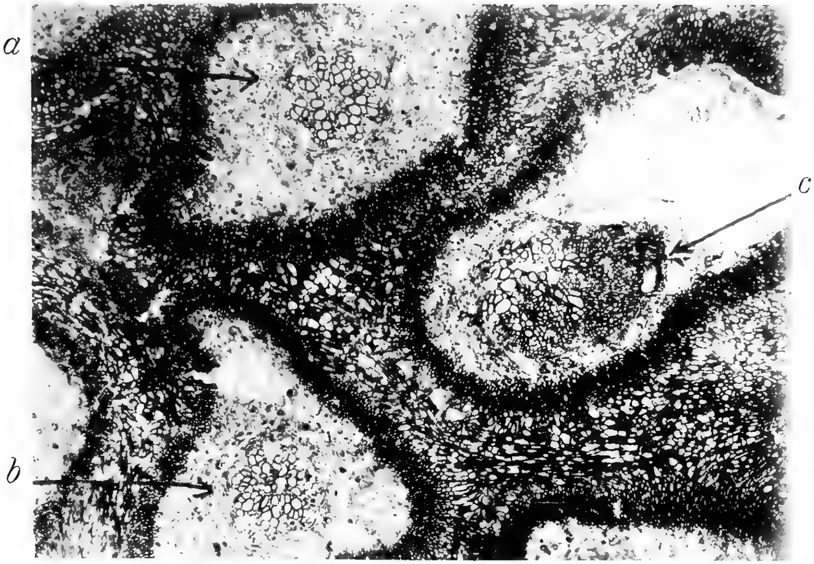


Fig 1

Fig 2

S. B. Bolas & Co. Collotype.

PSARONIUS CROMPTONENSIS.

Manchester Memoirs, Vol. xliii. (1899), *No.* **3**.

III. Hymenoptera Orientalia, or Contributions to a knowledge of the Hymenoptera of the Oriental Zoological Region. Part VIII.

The Hymenoptera of the Khasia Hills. First Paper.

By P. CAMERON.

[*Communicated by J. Cosmo Melvill, M.A., F.L.S.*]

Received October 17th. Read October 18th, 1898.

This paper may be looked upon as the commencement of a new series of the Contributions to a knowledge of the Hymenoptera of the East Indies, first begun in these *Memoirs* in 1889. It may be regarded in the light of a new series in two respects; in the first place it makes known to us the Hymenoptera of a large district which has not hitherto been worked, so far at least as the Hymenoptera are concerned; and, in the second place, the collections about to be described and catalogued contain large numbers of species belonging to groups about which up till now our information has been of the most limited description, at any rate as regards the Oriental Region.

That the part of the eastern Himalayan Range known as the Khasia Mountains is likely to prove exceedingly rich in species there can, I think, be no doubt at all. This seems likely to be more particularly the case with the parasitic species, *Ichneumonidæ*, *Braconidæ*, &c., which, judging from our present information, are rare in the Central regions and in the South of India, where their place is probably taken by parasitic Diptera.

The species recorded and described in this and the

following papers are now in the collection of Mr. G. A. J. Rothney. They form a notable addition to our knowledge of the hymenopterous fauna of the mountains; but these papers can only be looked upon as a beginning towards an enumeration of the species, which must number many hundreds, and more probably thousands. The fact that in the comparatively small region of Sikkim there are found about 600 species of Butterflies, and probably thousands of Moths, is in itself sufficient evidence of the rich harvest which awaits the student of Hymenoptera, when collectors begin to pay attention to other groups than the Lepidoptera. The specimens were collected by the native Lepchas, some of whom make excellent collectors; but, as might be expected, they only collect large or medium sized species.

An excellent description of the Khasia Mountains is to be found in that admirable book of travels, Hooker's *Himalayan Journal.*

Judging from the present collection, the Hymenoptera of the eastern Himalayan Mountains appear to be markedly different from those found in the western part of the range; but our knowledge of the fauna of the western parts of the group, to say nothing of the northern plains and of the mountains of Central India, is so small that it is useless at present to discuss the geographical distribution and relationship of the species. Some of the species constitute well-marked new generic types. In establishing these, I have not taken Foerster's generic revision of the *Ichneumonidæ* as a basis. If I were to do so, I should be compelled to form a very much larger number of new genera; but as the system adopted by Foerster appears to me to be largely artificial, I have not followed it.

Since the publication of Smith's Catalogue,* in 1869,

* A Catalogue of the Aculeate Hymenoptera and Ichneumonidæ of India and the Eastern Archipelago. *Proc. Linn. Soc.*, 1869.

there has not been much added to it so far as regards the *Terebrantia*—only a few papers by Van Vollenhoven, Westwood and myself have been published. In Mr. W. F. Kirby's Catalogue,† forty-five species of Sawflies and Woodwasps are enumerated from India.

SIRICIDÆ.

TREMEX FLAVICOLLIS, *sp. nov.*

Niger, longe fulvo-hirtus; prothorace lineisque abdominis late flavis; pedibus nigris, tibiis tarsisque late flavis; alis flavo-hyalinis, apice fumatis. ♀.

Long. 22; terebra 5 mm.

Antennæ bluish-black, 18-jointed, the apex distinctly attenuated, the scape darker, the apex rufo-testaceous; the middle of the flagellum thickly covered with short, stiff, black hairs, especially on the apices of the joints. Head with a brassy-purple tinge, thickly covered with long, fulvous hair, which is longest and thickest on the front; rugosely punctured on the front, the vertex with the punctures not so deep and more widely separated, the orbits below the antennæ smooth and shining, the face largely raised above this smooth part and strongly and closely punctured, the raised part roundly curved and with a blunt, short, triangular tooth near the middle; mandibles above closely punctured. Prothorax yellowish-testaceous, the base slightly and roundly incised, above thickly covered with rough tubercles and sparsely with pale hairs. Mesonotum rugose, thickly covered with long, fulvous hair. Scutellum smooth and shining, blue; the median segment opaque, rough. The pleuræ and sternum thickly covered with long, fulvous hair, strongly punctured, and with a bluish tinge. The legs have the coxæ, trochanters and femora black; the tibiæ pale testaceous,

† List of Hymenoptera. Vol I. *Tenthredinidæ and Siricidæ.* 1882.

blackish at the apex; the tarsi black, with the greater part of their basal joint yellowish-testaceous at the base; they are all thickly covered with pale hairs; the femora are strongly punctured and have a purplish tinge. The costa, stigma and nervures are rufo-testaceous. Abdomen black, the apex with a violaceous tinge; the basal two segments, and the fourth more broadly, are lined with yellow at the base; the last segment is roundly depressed at the base, where it is purple and almost smooth, not rough like the rest of the segment; the apex of the penultimate segment behind it is semicircularly incised, the edge of the incision being acutely raised. The basal ventral segments are smooth and shining, their apices and central parts yellowish-testaceous; the apical ventral segments are coarsely punctured; the spine is roughly serrate below; the sheaths of the ovipositor black, dark ferruginous on the lower side, its sides coarsely, somewhat obliquely, striated; the top near the apex with some short, stout, irregular teeth.

Comes near to the East Indian *T. Smithii* Cam., but that has the wings purplish-hyaline, with a hyaline spot in the second brachial cellule and one in the middle of the hinder wings; the body blue-black, the thorax without yellow, the base of the hinder tibiæ and of the hinder tarsi only yellow, &c.

XIPHYDRIA QUADRIMACULATA, *sp. nov.*

Nigra; mandibularum basi late, maculis quatuor abdominis basi, basi tibiarum late basique tarsorum posticorum albis; alis hyalinis, nervis stigmateque nigris. ♀.

Long. 13 mm.

Antennæ 12-jointed: the scape bare, shining, dilated at the apex; the flagellum distinctly tapering towards the apex, where the joints are brownish beneath; the tenth

and eleventh joints are broadly, but not deeply, curved beneath. Head opaque, the vertex and occiput more shining; almost impunctate; the vertex closely punctured above, the lower part closely transversely striated; between and below the ocelli more strongly obliquely striated; between the antennæ rugosely punctured; in the middle is a short, narrow, deep, longitudinal furrow. Mandibles broadly white at the base, the base on the lower side narrowly black; the base and apex of the teeth piceous; the apices of the palpal joints testaceous, the front, face and base of the mandibles thickly covered with short, white hair; the lower part of the vertex is raised in the middle, the raised part being bordered by a narrow, indistinct furrow. Thorax black, closely rugosely punctured; the propleuræ coarsely rugosely punctured and deeply triangularly incised in the middle above, the base and apex being rounded; its lower side at the apex white. Mesopleuræ closely rugose, running into reticulations in the middle; the apex bordered by a sharp keel behind; median segment coarsely rugosely punctured, widely and deeply depressed in the middle; the cenchri are large and white. Median segment coarsely punctured, most strongly on the outer side, the sides of the cleft being almost smooth and they are shining. Metapleuræ deeply excavated in the middle, narrowed below, where in the middle they are crenulated; in the middle behind these is a large depression. Legs black; the base of the tibiæ—the hinder pair very broadly especially on the outer side—and the basal joint of the hinder tarsi, white; the claws and calcaria ferruginous; the former toothed at the base. Wings clear hyaline; the first radial cellule short, about one-fourth of the length of the second. The second cubital cellule is longer than the first and more than twice the length

of the third; the first recurrent nervure is roundly curved and is received in the basal fourth of the cellule; the second is oblique, straight, only slightly curved near the cubital nervure; the third cubital cellule is a little wider at the top than at the bottom; the third transverse cubital nervure is bullated at the top and bottom. Abdomen closely punctured at the base, the middle segments aciculated, the apical smooth; on the apical half of the second segment is a white mark at the side; the side of the third segment is almost entirely white. The sheaths of the ovipositor are punctured and covered sparsely with fulvous hair.

This makes the second species of *Xiphydria* recorded from India.

TENTHREDINIDÆ.

Abia melanocera, *sp. nov.*

Cupreo-viridis; antennis nigris, basi rufo-testaceis; apice femorum tibiis tarsisque pallide flavis; alis hyalinis, medio fumatis; costa stigmateque rufo-testaceis. ♀.

Long. 10 mm.

Antennæ black, the scape rufo-testaceous, the apical three joints forming a club, all three are distinctly separated, the last joint slightly shorter than the preceding, the basal joint of the club is distinctly longer than either of the apical and narrowed at the base, the last joint is slightly oblique; the vertex and outer orbits are brassy, almost golden, closely and strongly punctured, thickly covered with long, dark hair, broadly triangularly depressed behind the ocelli, and more widely and deeply in front of the hinder pair; the middle of the vertex is bluish, not golden. Below the antennæ is a wide and deep furrow, which is prolonged downwards at the sides. The face is coarsely punctured, the labrum large, smooth, the apex

rounded, slightly depressed in the middle, and thickly covered with long, blackish hairs. Mandibles rufous, the teeth black; the palpi pale fulvous-yellow. Mesonotum and scutellum strongly punctured, the scutellum more strongly at the base, covered, but not thickly, with longish, dark fuscous hair, the middle lobe is deeply and widely hollowed in the middle; the lateral furrow is deeper and more clearly defined at the bottom near the apex; the lateral lobes are distinctly separated at the apex by a wide, but not very deep, furrow, which has, at its base, a narrow, longitudinal keel; the depression at the base of the scutellum is deep and smooth. The scutellum is more coarsely punctured thanthe mesonotum. The coxæ, trochanters, and the greater part of the femora dark blue, mixed with brassy tints; the apical joint of the trochanters testaceous; the apex of the femora, the tibiæ and the tarsi stramineous; the apices of the tarsi ferruginous; the claws are bifid. Wings fulvo-hyaline, a distinct smoky cloud at the base of the stigma, darkest at the top. Abdomen closely punctured, more strongly and closely punctured on the basal segments; the segments distinctly convex, the depressions deep, smooth, the basal one shagreened; the keel on the basal segment is stout and distinct, on the second narrower and less distinct, especially towards the apex.

Belongs to *Abia, sensu Str.*, and comes near to *A. nitens* L., except that the antennæ are black. The antennæ are distinctly 7-jointed, the scutellum largely convex, distinctly raised above the mesonotum; the claws sharply bifid, and the keels on the first and second abdominal segments clearly defined; the tarsal patellæ well developed, and the puncturing on the abdomen deep and well marked.

Species of *Abia* have been recorded from China and Japan, but none hitherto from the Oriental Region proper.

HYLOTOMA ALBOBALTEATA, *sp. nov.*

Caerulea; abdominis segmento secundo, tibiis basique tarsorum albis; alis hyalinis, apice fuscis. ♀.

Long. 10 mm.

Antennæ nearly as long as the head and thorax united, black, the scape covered with longish, black hair. Head thickly covered with white hair below the antennæ, above them only sparsely haired. The frontal area large, its apex triangular, inside finely punctured; its sides distinctly raised; the face broadly projecting in the middle; the apex of the clypeus widely incised in the middle, the sides of the incision oblique, mandibles piceous in the middle; the palpi pale, suffused with fuscous. Thorax smooth and shining, thickly covered with a pale down. Legs blue-black; the tibiæ and the greater part of the basal joint of the tarsi white, thickly covered with white hair; the four anterior tibiæ are blackish behind, the apex of the hinder tibiæ fuscous; the base of the second joint of the hinder tarsi white. Wings hyaline; the costa and stigma fuscous, the nervures darker; at the top the second cubital cellule is as long as the second; at the bottom shorter than it; the first recurrent nervure is received in the basal third; the second nearer the base of the cellule. Abdomen with the second segment white all round; the apical segments thickly covered with soft, white hair; the last segment is widely incised.

Comes nearest to *H. albocincta* Cam. from Nepaul, but that has the third, not the second segment, yellow, the "fore coxæ and greater part of the legs pale yellowish," &c., and the tarsi are not black, only white at the base as in the present species. The fuscous cloud extends over the radial, the second and third cubital and more faintly on to the top of the fourth cellules. The tegulæ are whitish.

HYLOTOMA MACULIPENNIS, *sp. nov.*

Caerulea, dense albopilosa; antennis nigris; alis hyalinis, macula substigmatali violacea. ♀.

Long. 9 mm.

Antennæ black, the flagellum thickly covered with short, stiff hairs; the scape more densely with longer, paler hair. Head smooth and shining; the frontal fovea large, smooth, deep behind shallow in front, and merging into the face, not being clearly defined at the apex. The apex of the clypeus is obliquely depressed at the point, where it is slightly incised; mandibles deeply grooved in the middle, their lower side piceous; the palpi blackish, thickly covered with white hair. Thorax smooth and shining, the pleuræ and sternum thickly covered with white hair. The prothorax above is sharply keeled at the base, the keel being bordered behind by a furrow; in its centre behind is a fovea. The parapsidal furrows are wide and deep; in the middle at the base is a short, deep furrow; the basal lobe is joined, at its apex, to the scutellum by a furrow. The scutellum is strongly convex; the apex has a more abrupt slope than the base. Wings hyaline, the nervures and stigma black; between the stigma and the cubital nervure is a fuscous cloud which occupies the whole of the second cubital cellule and the base of the third, the part of it in the latter being obliquely narrowed; the second cubital cellule at the top is a little shorter than the third, below, if anything, longer than it; the first recurrent nervure is received near the basal third, the second about the same distance from the base of the third cellule. The legs are thickly covered with short, white pubescence; that on the tarsi shorter, thicker and darker; the claws are rufous. Abdomen shining, almost bare.

Allied to *H. janthina* Klug, but that species may be known from it by the entire apex of the fore wings being clouded, not a cloud under the stigma only.

HYLOTOMA LUTEIVENTRIS, *sp. nov.*

Nigra; abdomine luteo, supra late nigro; alis fusco-violaceis, nervis stigmateque nigris. ♂.

Long. 7 mm.

The scape of the flagellum black; the flagellum brownish, thickly covered with long, black hair. The face has a slight bluish tinge, closely and minutely punctured, thickly covered with short, fuscous hair; broadly, triangularly projecting in the middle; the sides of the projection bordered by a furrow, which is deepest and widest below. The apex of the clypeus has a shallow incision; the mandibles are black, with bronzy tints; the palpi are black, covered with white hair; the apical joint of the maxillary obscure testaceous. The front and vertex are thickly covered with short, black hairs; the centre of the front raised, the raised part becoming higher towards the apex; its centre hollowed; the depression of equal width, except that it is slightly narrowed near the apex. Thorax black, with bluish tints; covered with short, black pubescence; the scutellum more thickly with longer, black pubescence; the post-scutellum very smooth and glabrous with a violaceous lustre and deeply and widely depressed at the base. The basal segment of the abdomen coarsely aciculated; the other segments are smooth, the black with blue and violaceous reflections on the sides, the apical two and and the ventral segments luteous. Legs blue-black, thickly covered with short, black hair. The wings are lighter-tinted towards the apex; the second cubital cellule at the top is shorter, at the bottom slightly longer, than the third; the first recurrent nervure is received near the basal fourth of the cellule; the second about the same distance from the base of the third cellule.

Allied to *H. zanthogaster* Cam.

TENTHREDO CAERULEA, *sp. nov.*

Caerulea; basi mandibulorum, labro femoribusque subtus albis; alis fusco-hyalinis, fascia substigmatali fumata. ♂.

Long. 12 mm.

Antennæ not much longer than the abdomen, distinctly tapering towards the apex, the basal four or five joints blue, tinged with purple, the apical joints black, the scape closely punctured, sparsely pilose; the flagellum thickly covered with short, black hair. Head smooth, shining, impunctate, the labrum white; the occiput sharply margined; the vertex roundly raised in the middle; the hinder part separated by an oblique depression from the ocellar region; the frontal area narrowed behind, the sides sharply and stoutly keeled, the apex more depressed and with a raised conical piece in the middle. Clypeus with a raised semi-circular incision, smooth; the labrum and base of mandibles thickly covered with long, white hair; the mandibles are broadly white at the base; the apical joints of the palpi are white. The middle lobe of the mesonotum is raised, with a slope from the middle to the base and apex, the former being the shorter and steeper; the furrow is deep; the apex sharply triangular; the middle lobe bears large, deep punctures, all clearly separated; the lateral lobes are less distinctly punctured. Scutellum pyramidal, rounded on the top; sparsely covered with large, deep punctures; the apex with a more oblique slope than the base. The base of the metanotum has an obliquely rounded slope, the top of which is roundly raised, the sides being more narrowly roundly raised; the apex is bluntly, triangularly raised in the middle and sharply separated from the basal part of the segment; the sides are finely striated in the middle. Propleuræ deeply depressed in the middle, sharply keeled on the base. Mesopleuræ smooth at the base and apex;

the centre strongly deeply reticulated. The sternum is thickly covered with short, fuscous hair, is narrowly furrowed down the middle and stoutly tuberculated on the apex at the sides; the hair on the pleuræ is longer than on the breast. Legs thickly covered with long, white hair; the tibiæ and tarsi are darker than the femora and are more thickly covered with white hair; the under sides of the femora, of the anterior tibiæ, and more or less of the trochanters on the under side are white; the claws are bifid; the lower tooth of the front calcaria stands out obliquely and is shorter and somewhat stouter than the other. The first recurrent nervure is received shortly before the middle of the cellule; the second quite close to the second transverse cubital nervure; the third cubital cellule is a little longer than the second. The abdomen is much more suffused with cobalt-blue than the thorax, particularly above.

Comes near to *T. clypeata* Cam. and *T. metallica* Cam. but is quite distinct from either.

TENTHREDO SPINOSA, *sp. nov.*

Nigra, abdomine testaceo; antennis albis, basi nigris; pedibus anterioribus flavo-testaceis; femoribus tibiisque posticis rufo-testaceis; tarsis posticis albis; alis fulvo-hyalinis, stigmate testaceo. ♂.

Long. 14 mm.

Antennæ white, the apical joints tinged with testaceous; the basal three joints black; the first testaceous below, the third white at the apex beneath. Front and vertex broadly and deeply depressed at the sides; shining, impunctate; the front ocellus is surrounded by a semicircular furrow behind; in front of it, on either side, is a short, deep depression; above the antennæ is a long, wide and deep one; the vertex behind the ocelli is

bluntly conical. The clypeus, labrum, mandibles, except their apex, and the palpi are yellowish-white; the occiput margined distinctly. Thorax black, the mesonotum obscurely punctured, more strongly on the middle lobe, which is widely and deeply furrowed down the middle; thickly covered with short, black hair. Scutellum pyramidal, sparsely covered with long, black hair; the apex with a long, oblique slope; the space between the cenchri depressed; the part behind it broadly raised. Propleuræ widely and deeply depressed in the middle, where they are finely aciculated; above there is a wide, deep, curved depression, narrowed at the base. Mesopleuræ bearing large, deep, distinctly separated punctures, which are more numerous on the lower than on the upper side; on the lower side, next to the sternum, is a wide and deep furrow clearly separating the sternum from the pleuræ; the edges of the sternum are margined and end at the apex in large, stout, somewhat triangular, teeth, which are whitish-testaceous at the apex and project obliquely. The four front legs are yellowish-testaceous; the middle tibiæ and tarsi have a fulvous tinge; the fore coxæ are black, testaceous at the apex; the middle coxæ are pale yellowish, broadly black at the base; the hinder femora and tibiæ are dark fulvous-testaceous, their coxæ somewhat paler, the tarsi pale yellowish, more fulvous at the base. Wings fulvo-hyaline, the costa and stigma fulvous, the second cubital cellule is not much more than one-half the length of the third; it receives the recurrent nervure shortly before the middle; the second recurrent nervure is received in the apical fourth. Abdomen rufo-testaceous, paler beneath.

TENTHREDO ANNULITARSIS, *sp. nov.*

Pallide olivacea, nigro-maculata; pedibus pallidis;

coxis late, basi femorum medioque tibiarum posticarum nigris; alis hyalinis, apice fumatis. ♀.

Long. 13 mm.

Antennæ pallid yellow, the second and the penultimate joints blackish beneath; the third and fourth joints subequal. Head shining, impunctate; the vertex thickly covered with short, black hair; the face, clypeus and labrum with a few long, pale hairs; the occiput in the middle, the middle of the vertex and the front more broadly black; the front broadly depressed in the middle at the apex, the depression bordered by broad keels which are raised and rounded near the apex; the apex of the clypeus broadly rounded; the apex of the labrum fringed with golden-fulvous hair; the apex of the mandibles black. The basal lobe of the mesonotum roundly and distinctly raised; the basal half black, brownish in the middle, its furrow narrow, complete; the lateral lobes are broadly black on the outer side; all three are thickly covered with short, black hair. Scutellum pyramidal, smooth, sparsely covered with long, black hair. The base of the propleuræ broadly black; the upper part, the base, the apex more transversely, and the lower part more broadly, black; the mark on the lower side is incised in the middle. Wings fulvo-hyaline; the apex darker, smoky, with a violaceous tinge; the second cubital cellule is distinctly shorter than the third, and receives the recurrent nervure in the middle, the second is received quite close to the base of the cellule. Legs coloured like the thorax; the hinder coxæ broadly behind the base of the hinder femora to near the apex, the base of the tibiæ broadly, and the apices of the joints of the four anterior tarsi, black; the tibiæ and tarsi thickly pilose, the hinder tarsi more thickly than usual. The bases of the abdominal segments are lined with black.

TENTHREDO SIMLAENSIS, *sp. nov.*

Viridis; capite thoraceque late nigro-maculatis; antennis, tibiis tarsisque posterioribus nigris; alis hyalinis. ♀.

Long. 11-12 mm.

Hab. Simla.

Antennæ black, as long as the head and thorax united, the third joint distinctly longer than the fourth. The front and vertex are black, except the former above the antennæ and two short broad lines on the vertex behind the ocelli and extending a short way down the occiput; the frontal area distinct, depressed; its sides broad, broader and more raised at the apex where they are green. The clypeus sparsely, the labrum more thickly covered with long, pale hair; the incision in the clypeus not rounded in the middle, the sides of the incision being straight, oblique, not rounded. Mandibles broadly black at the apex. Prothorax green, broadly black in the middle above. Mesonotum black, except the apex of the middle lobe; it is smooth and shining. Scutellum, post-scutellum and the scutellar keels, green; the scutellum not much raised; the base with a long, the apex with an abrupt, slope; it is covered with long, black hair. The mesopleuræ black under the wings, its lower edge and the mesosternum black. The four anterior tarsi are broadly annulated with black; the middle tibiæ are black behind; the hinder tibiæ and the hinder tarsi are entirely black. Abdomen has down the sides black marks, which are broader than long; the sheaths of the ovipositor are black at the apices.

TENTHREDO KHASIANA, *sp. nov.*

Olivacea, late nigro-maculata; flagello antennarum nigro; pedibus nigro-maculatis; tibiis tarsisque posticis

nigris; alis hyalinis, apice fumatis; stigmate sordide testaceo. ♀.

Long. 15 mm.

Antennæ not much longer than the thorax, distinctly tapering towards the apex, black, the scape yellowish-white. Head black; the face, clypeus, labrum, base of mandibles, palpi, the inner orbits broad at top and bottom, much narrowed towards the middle; two short, broad lines behind the ocelli and the upper and outer orbits broadly, yellow. Clypeus broadly, but not deeply, incised, slightly oblique at the base; the front shallowly depressed; the lower ocellus with a rounded keel behind it; there is a transverse furrow behind the ocelli; the middle of the vertex raised, clearly separated. Thorax black, the apical two-thirds of the middle lobe of the mesonotum on the inner side; two marks opposite its apex on the lateral lobes; the scutellar keels, two large marks on the base of the scutellum, a semicircular mark at its apex; the sides broadly and the apex of the median segment, the edge of the pronotum, the base of the propleuræ more broadly, the apex more narrowly, a large, oblique mark, narrowed in the middle, on the mesopleuræ, two large oblique marks on the metapleuræ and a mark, narrowed at the base, on the apex of the mesosternum in the middle, yellow. Mesonotum shining, finely punctured; its middle lobe furrowed throughout; the scutellum roundly convex, the basal and apical slopes about equal; it is shining, and sparsely haired. Legs pale yellow; the apex of the fore femora, the whole of the hinder tibiæ and the apices of the tarsal joints, black; the middle femora have the apical half lined with black; the tibiæ are more broadly lined with black behind, and the tarsi are entirely black; the hinder femora, coxæ and trochanters are broadly black behind, and the hinder tibiæ and tarsi are entirely black.

The radial nervure is received in the middle of the third cubital cellule, which is not much longer than the third, the first recurrent nervure is received in the middle, the second in the basal third of the cellule. Abdomen black, the apices of the basal segments olive-coloured.

TENTHREDO BICARINATA, *sp. nov.*

Ferruginea; apice antennarum lineisque duabus mesonoti nigris; alis fusco-violaceis, stigmate nervisque nigris. ♀.

Long. to apex of first abdominal segment, 10 mm.

Antennæ rufous, yellow towards the middle; the apical half of the sixth and the apical three joints entirely black. Head rufo-ferruginous, the base of the clypeus and of the labrum, the lower orbits outside, and the mandibles, yellow; the apex of the mandibles black. The middle of the vertex bounded by two deep, narrow furrows, and having in the centre, near the apex, a longitudinal, not very clearly defined, keel; outside the anterior ocellus is a narrow keel; from the apex of these, on the inner side, a stout keel runs to the base of the antennæ. The incision on the apex of the clypeus is broad and not very deep; the hinder edge of the head is sharply keeled all round. Mesonotum closely punctured, the middle lobe furrowed down the middle; its apex lemon-yellow; the middle lobes are broadly black on the outer side, and covered with short, black hair. Scutellum sharply pyramidal, thickly covered with longish, black hair, the top smooth and shining, the post-scutellum aciculated and with only a few punctures. Propleuræ smooth, impunctate, black, except on the top, and more narrowly at the base and apex. Mesopleuræ rugosely punctured, most coarsely on the lower side; tuberculated and keeled on the lower edge at the base and more distinctly behind, the apex excavated, black above, the

base of the metapleuræ broadly black. Wings violaceous, the base lighter, and more yellowish in tint; the stigma and nervures black. Legs coloured like the thorax; the four hinder coxæ broadly black behind. The apex of the abdomen is broken off in all the examples.

TENTHREDO CARINIFRONS, *sp. nov.*

Nigra; capite thoraceque albomaculatis, antennis nigris, albo-annulatis; pedibus anticis albidis, posterioribus rufis; abdomine ferrugineo, apice nigro; alis violaceis, stigmate nigro. ♀ *et* ♂.

Long. 17 mm.

Antennæ black, the greater part of the fourth and fifth and the base of the sixth clear white, the sixth and seventh joints thickened; the basal joints thickly covered with short, black hair. Head black; the labrum, the middle of the clypeus broadly, the inner orbits—broadest at the top; a transverse mark behind the eyes at the top, a larger one on the lower side; the base of the mandibles broadly and the palpi, white. Head smooth, shining; the frontal depression large, oval; behind bordered by a deep and wide furrow; there is a triangular depression between the ocelli; its sides striated; behind is a smooth, curved furrow; the middle of the vertex is bordered by a wide depression; the occiput above is sharply margined. Thorax shagreened, the mesopleuræ more coarsely than the rest; a broad line on the pronotum, not reaching to the base, and with a small oblique dilatation on its middle; the base of the tegulæ, a line on each side of the middle lobe of the mesonotum, the scutellum, except at the apex, the post-scutellum, a large mark in the centre of the pro- and of the meso-pleuræ, a smaller one on the lower side of the mesopleuræ, longer than broad and narrowed towards the apex, a mark, narrowed at the top, over the middle

coxæ and a longer one, enclosing the spiracles, over the hinder pair, yellowish-white. The mesosternum is closely punctured, thickly covered with short, pale hair, and bears two large, white marks on the apex. The front legs are white, lined with black behind ; the four hinder legs bright ferruginous, their coxæ black in front, the middle trochanters yellow. Wings almost uniformly violaceous, if anything paler at the base. The base and apex of the abdomen black, with a violaceous tinge, the middle ferruginous.

TENTHREDO COMPRESSICORNIS, *sp. nov.*

Nigra; capite thoraceque albomaculatis; antennis nigris, medio albis; pedibus pallide fulvis, basi coxarum nigro; alis violaceis.

Long. to apex of first abdominal segment, 7 mm.

Antennæ black, the apical half of the fourth and the fifth joints, except at the apex, white. Head shining, impunctate; the frontal area large, rounded at the top; depressed, raised in the middle; the vertex distinctly raised; a narrow, but deep, furrow behind the ocelli; the face, inner orbits narrowly, the outer, especially below, more broadly; the sides of the clypeus at the base; the labrum and the base of the mandibles, yellowish-white; the black apex of the clypeus has a curved incision. Thorax black; the edge of the pronotum, broadly behind, more narrowly at the base, the apex of the middle lobe of the mesonotum, the sides of the lateral lobes on the inner sides opposite it; the scutellum, postscutellum, a large mark on the base of the mesopleuræ above, narrowed at the base below, a smaller mark, pear-shaped, on the apex lower down, a small mark on the base of the metapleuræ above and a larger one over the coxæ, pale yellow. Mesonotum closely punctured; the scutellum smooth, its apex covered with short,

black hair; its base with a long, oblique slope. The propleuræ and the upper part of the mesopleuræ smooth; the lower part of the latter with large, widely separated, shallow punctures. Legs pale bone-yellow; the base of the coxæ, the four anterior femora behind, and, to a less extent, in front and the four anterior tibiæ behind, black. Wings at the base fuscous-violaceous, from the base of the stigma dark violaceous; the hinder wings similarly coloured but lighter in tint. The basal segment of the abdomen bone-yellow, the middle dark blue, the apical broken off.

The apex of the abdomen is unfortunately broken off, but the characters which remain are sufficiently distinct from anything described to warrant the description of the species. The four apical joints of the antennæ are compressed.

TENTHREDO VIOLACEIPENNIS, *sp. nov.*

Rufa; abdominis apice, tibiis tarsisque posticis nigris; alis fusco-violaceis. ♀ et ♂.

Long. 17 mm.

Hab. Simla.

Antennæ short, stout, uniformly rufous; the scape covered thickly with long, pale hair. Front and vertex coarsely punctured; the border of the frontal area broad, distinctly raised and closely punctured; the apical half of the enclosed space smooth and shining; the basal closely punctured; the vertex impunctate, smooth; the occiput not margined. Clypeus and labrum smooth, the former roundly incised, the latter yellowish; the apex of the mandibles black. On the thorax there are two large marks on the lateral lobes of the mesonotum, the greater part of the propleuræ, more or less of the apex of the meso- and the base of the meta-pleuræ, black. Meso-

notum closely punctured, thickly covered with short, black hair; the middle lobe widely depressed at the base, finely furrowed down the middle. Scutellum pyramidal, but not sharply so, the top being broadly and equally rounded; it is thickly covered with short, black hair. The legs are coloured like the thorax; the anterior are paler at the base; the hinder tibiæ and tarsi are black, except the apical joint of the tarsi. Wings smoky-violaceous, lighter, of a more yellowish tinge, before the stigma; the stigma and nervures black, the costa ferruginous. The apical half of the abdomen black; the apical three segments entirely so.

The ♂ is similar to the ♀; the middle lobe of the mesonotum is black at the base.

The following species may constitute the type of a new genus when the Indian sawflies have been properly studied.

Head large, wider than the mesonotum, behind distinctly and sharply margined or keeled. Eyes parallel, not converging below; separated by a clear space from the base of the mandibles, and distinctly margined. Antennæ longish, thickened beyond the middle; the apex attenuated; the third joint not much longer than the fourth. Mandibles with only one long apical tooth. Wings, body and legs as in *Tenthredo*. The accessory nervure in hind wings interstitial.

It will be seen that it differs from *Tenthredo*, as defined by Konow, in the eyes not converging beneath, and in not reaching to the base of the mandibles, in which respects it agrees with *Rhogogastera*, but it differs from that genus in having the antennæ much longer and in the humeral cellule in the hind wings not being appendiculate.

The head is larger than usual, and much more sharply and distinctly margined behind; the vertex is distinctly furrowed, and the frontal area is distinctly defined.

TENTHREDO MEGACEPHALA, *sp. nov.*

Flavo-testacea; flagello antennarum, femoribus, tibiis, tarsis posticis abdominisque apice nigris; alis flavis, apice fumatis. ♀.

Long. 17 mm.

The scape of the antennæ covered with a longish, the flagellum densely with a short, black pubescence. Head large; the occiput sharply margined; the vertex raised in the middle, the furrows wide and deep, extending below the ocelli; the raised part of the vertex indistinctly keeled down the middle. The front is raised in the middle below the ocelli; the apex of the raised part depressed, narrowed gradually towards the apex, and with a keel in the middle; the keel broad at the base, gradually narrowed towards the apex. Clypeus and labrum smooth, pallid yellow; the apex of the clypeus roundly incised; the apical half of the labrum and the basal half of the mandibles covered with long, fulvous hair; the apex black. Mesonotum of a darker colour than the rest of the thorax; closely and rather strongly punctured, thickly covered with short, black hair; the middle lobe raised and furrowed in the middle. Scutellum large, pyramidal, the top with a longitudinal keel, and bearing long, black hair. The cloud in the fore wings extends from the end of the transverse radial, the second transverse cubital, and the second recurrent nervures; there is a distinct smoky cloud in the apex of the hinder wings. The four anterior legs are yellow, paler at the base; the apices of the tarsi infuscated; the hinder legs black, except the coxæ and trochanters; all the tibiæ and tarsi are thickly covered

with fulvous hair; the hinder calcaria rufous. The basal five segments of the abdomen luteous; the sixth and seventh violet-black above, the others entirely so.

MACROPHYA FOVEIFRONS, *sp. nov.*

Nigra; ore, linea pronoti, scutello, postscutello, maculaque mesopleurali flavis; pedibus flavis; dimidio apicali femorum posticorum apiceque tibiarum posticarum nigris; alis fulvo-hyalinis, stigmate fusco. ♀.

Long. 9-10 mm.

Antennæ short, black, almost bare, or with only a microscopic pile; the third joint distinctly longer than the fourth. The head shining, impunctate; the front and vertex raised; the former depressed in the middle; the sides of the depression wide; the apex rounded and deeply and roundly depressed; there is a deep, narrow furrow between the ocelli; behind them is a yellow mark, wider than broad, and slightly dilated behind. The clypeus, labrum, base of mandibles and palpi, yellow; the apex of the clypeus deeply and roundly incised; the sides sharply triangular; the apex of the labrum depressed. Thorax shining, black; the edge of the pronotum, a somewhat triangular mark on the lateral lobes of the mesonotum opposite the apex of the middle lobe, the scutellum, postscutellum, the apex of the median segment, the apex of the propleuræ in the middle, a large mark, longer than broad and narrowed at the apex, in the middle of the mesopleuræ and one over the hinder coxæ, yellow. Mesonotum shining, covered with short, fuscous hair; and with large, distinctly separated, punctures. Scutellum sparsely covered with long, pale hair; postscutellum coarsely punctured laterally; the middle smooth and roundly raised. Legs yellow; the coxæ, except at the apex, almost the apical half of the hinder femora, and

the apex of the hinder tibiæ, black. The first transverse cubital nervure is bullated; the second is curved backwards. Abdomen above shining, black with a bluish tinge; the ventral segments broadly yellow at the sides.

MACROPHYA MACULICORNIS, *sp. nov.*

Nigra; apice antennarum, ore, linea pronoti, scutello pedibusque lateralibus anterioribus flavis; pedibus posticis fulvis, apice femorum et tibiarum basique tarsorum nigris; alis hyalinis, nervis stigmateque nigris. ♂.

Long. 10 mm.

Antennæ black, the apical four joints white, the third joint distinctly, but not much, longer than the fourth. Head black; the labrum, clypeus, base of the mandibles, the palpi and a mark, wider than long and incised in the middle, at the apex, yellow; the front and vertex rather strongly punctured; the front raised in the middle, the centre of the raised part depressed; more widely and deeply at the apex than at the base. Thorax black, the edge of the pronotum broadly, narrowly at the base; two marks on the mesonotum near the apex of the middle lobe; two large marks on the sides of the scutellum, narrowed towards the apex, its apex and the apex of the postscutellum, the sides of the propleuræ above, and an oblique mark over the middle coxæ, yellow. Mesonotum closely punctured; the scutellum with the punctures larger and more widely separated. The apex of the propleuræ and the mesopleuræ closely and strongly punctured. The four anterior legs are pallid yellow; the hinder coxæ strongly punctured and pallid yellow; largely black above at the base where there is a yellow mark in the middle; the femora and tibiæ fulvous; the apical third of the femora and the apical fourth of the tibiæ, black; the tarsi pale, the base of the metatarsus and the calcaria

black. Wings hyaline, the stigma and nervures black; the first and third cubital transverse nervures are largely bullated. Abdomen black above; the base of the third segment broadly fulvous, the fulvous band dilated at the sides and middle; the ventral segments broadly banded with yellow; the apical entirely yellow.

The antennæ are longer than usual for a *Macrophya*, but on the whole it agrees better with that genus than with *Pachyprotasis;* the hinder coxæ and legs are also longer than usual; the coxæ reach near to the apex of the fifth abdominal segment. There is no cross nervure in the lanceolate cellule, which is divided into two by a considerably greater space than in *M. foveifrons.* The white tip of the antennæ is unusual for a *Macrophya.*

ALLANTUS MARGINICEPS, *sp. nov.*

Niger; ore, abdominis basi, coxis, trochanteribus tibiisque late flavis, alis violaceo-fumatis, stigmate sordide testaceo. ♀.

Long. 16 mm.

Antennæ scarcely so long as the thorax; the six apical joints distinctly thickened, almost bare. Head black, the clypeus and labrum yellow, shining, impunctate, sparsely covered with short, white hair. The front is broadly and deeply hollowed, the hollow divided in two by a transverse partition. The vertex in the middle behind is raised, the raised part broader than long and bounded by a deep furrow, which is, if anything, broader, deeper, and more curved at the sides than at the apex; the ocelli on the outer side are bounded by a deep furrow; there is a narrow one between the hinder pair, and an oblique one at the side of the front pair behind. The occiput is sharply margined above; behind, at the top, is a narrow furrow on the inner side of the margin.

Thorax shining, impunctate above; the furrow on the middle lobe of the mesonotum is wide and deep; the scutellum large, pyramidal, smooth; its basal and apical slope about equal in length. Propleuræ smooth, roundly, largely tuberculate in the middle above. The mesopleuræ bearing large, deep, irregular punctures; its extreme base smooth; the lower part, at the apex, largely, somewhat triangularly, projecting. Mesosternum bearing fine, widely separated punctures; its base oblique; the central longitudinal furrow minute; the apex, on either side of the middle, projects into triangular tubercles. Legs black; all the trochanters, the apices of the four hinder coxæ, the apices of all the femora narrowly, and the bases of all the tibiæ broadly—the hinder more broadly than the others—yellow. Wings fuscous-violaceous, the posterior and the hinder part of the anterior lighter in tint; the first recurrent nervure is received shortly before the middle; the second in the basal fourth of the cellule. Abdomen shining, the basal segments broadly, and the apices of the others narrowly, branded with yellow.

In certain lights the black colour has a distinct violaceous tint.

ALLANTUS BRUNNEUS, *sp. nov.*

Rufus, abdominis basi nigro; tarsis posticis pallide flavis; femoribus anterioribus supra nigris; alis fulvo-hyalinis. ♀.

Long. 13 mm.

Antennæ not much longer than the thorax; the apical four joints distinctly thickened; the third joint almost twice the length of the fourth; the ocellar region and the front distinctly raised; the former depressed in the middle, thickly covered with short, fuscous hair. Clypeus and labrum smooth, the latter with a yellowish

tinge, the former with a semicircular incision. Mandibles yellowish, the edges black, the apices piceous and black; the palpi pallid yellow. Mesonotum punctured, thickly covered with fuscous hair; the furrow on the basal lobe wide and deep, complete. Scutellum not much raised, rounded, covered with large punctures and with long, fuscous hair; the postscutellum smooth and shining, impunctate; the depression between the cenchri black. Propleuræ smooth, the apex of the lower half black. Mesopleuræ finely and closely punctured, especially at the base; the middle with some large, deep punctures; thickly covered with pale hair, as is also the mesosternum. The fore coxæ and trochanters are black below; the femora, tibiæ, and base of tarsi, yellowish in front, as are also their middle, but not so clearly; behind they are lined with black; the posterior coxæ are also lined with black before and behind above; the trochanters and femora are black above; the tarsi yellowish-white. Wings fulvo-hyaline, the fore pair distinctly smoky; the stigma and costa reddish fulvous; the first and second cubital cellules together are as long as the third; the first recurrent nervure is received shortly before the middle; the second near the basal fourth. Abdomen black above: the basal segments almost entirely black; the apical thickly covered with pale pubescence.

SIOBLA RUFICOLLIS *sp. nov.*

Nigro-caerulea; thorace rufo, mesosterno nigro, abdominis basi albolineato; pedibus albis, femoribus tibiisque nigro-maculatis; tarsis posterioribus nigris; alis hyalinis, apice late fumatis. ♀ *et* ♂.

Long. 10 mm.

Antennæ stout, the apical joints thinner; thickly covered with short, black, stiff hair; they are slightly

longer than the head and thorax united; the third joint is slightly, but distinctly, longer than the fourth. Head nearly as wide as the mesothorax, shining, impunctate, the front and vertex thickly covered with fuscous pubescence; the lower part of the front, the clypeus and the labrum thickly covered with long, white hair. The middle of the vertex and the ocellar region bounded by a deep furrow; that on the former deeper behind; the front is deeply depressed above the antennæ. Apex of clypeus roundly, but not deeply, incised; the labrum slightly depressed, its apex rounded; the apical joints of the palpi are fuscous, paler at the base. Thorax smooth, shining, impunctate, thickly covered with fuscous hair; the prothorax, mesonotum with scutellum and the greater part of the mesopleuræ above, sanguineous; the furrows on the mesonotum deep, that on the middle lobe wider and shallower; the middle lobe ends at the apex in a keel. Cenchri large, cream-coloured; the space between them rufous. All the trochanters, the apices of the coxæ, the base of the hinder femora, the four anterior tibiæ, the basal two-thirds of the basal pair and the base of the anterior tarsi white; the claws unequally bifid. The second and third cubital cellules are equal in length above; below the third is the longer; both the recurrent nervures are received in the basal third of the cellules. Abdomen blue-black, shining; the third segment and the base of the fourth dirty white.

Siobla is intermediate between the *Tenthredinides* and the *Selandriades*. The transverse basal nervure is united to the base of the cubital as in the *Tenthredinides*, but it has more the form of the *Selandriades*. The antennæ are short and thick; the eyes are large, and reach near to the base of the mandibles; the spurs are short, not one-fourth of the length of the metatarsus; the claws are bifid; the

lanceolate cellule has an oblique cross nervure; the third joint of the antennæ (which are short) is distinctly longer than the fourth; the patellæ are not developed.

ALLOMORPHA.

This genus was created by me for a Chinese species (*Trans. Ent. Soc., 1876, p. 463*). It belongs probably to the *Tenthredinides* rather than to the *Selandriades*, but actually is intermediate between the two. The transverse basal nervure is received before the base of the radial, not close to or joined to it, as in the *Selandriades*, with which it agrees in having the calcaria short, not reaching near to the middle of the metatarsus; the lanceolate cellule has an oblique cross nervure; there is only one middle cellule in the hinder wings; the clypeus is deeply incised; the mandibles are long, sharply pointed, and end in one long tooth; the eyes are large, almost parallel, and reach close to, but do not touch, the base of the mandibles. The antennæ do not taper towards the apex, and are long and slender. The claws are bifid. The antennæ appear to have three colours in all the species.

ALLOMORPHA VARICORNIS, *sp. nov.*

Fulva; antennis nigris, basi testaceis, apice albis; maculis mesonoti mesosternoque nigris; alis hyalinis, stigmate fusco, basi testaceo. ♀.

Long. 11 mm.

Antennæ not much longer than the abdomen, the basal three joints testaceous, the fourth, fifth, and the greater part of the sixth, black; the rest white. On the head the ocellar region, the front broadly in the middle

and the sutures on the vertex are black; the front is depressed; the clypeus and labrum are pale yellowish; the former closely punctured; its incision wide, deep; the labrum smooth, shining, rounded at the apex, its sides somewhat oblique and fringed with long, pale golden hair. Mandibles curved, sharply pointed, yellowish; the apex and inner side black; the palpi pale yellow. Thorax smooth and shining; the base of the basal lobe and the outer side of the lateral lobes broadly black; they are covered, especially the lateral, thickly with short, black hair. Scutellum convex, rounded, thickly covered with long, black hair; the basal depression is wide and deep. Propleuræ shining, smooth, black; the sides of the upper part rufous. Mesopleuræ bearing large, deep, roundish punctures; the base finely and closely punctured, the apex impunctate, oblique; the metapleuræ black, except in the middle above, where there is a wedge of rufous colour. Legs coloured like the body; the coxæ and trochanters yellowish; the hinder coxæ broadly black in front. Wings hyaline, with a slight fulvous tint; the second and third cubital cellules subequal; the first recurrent nervure is received near the basal third. Abdomen coloured like the thorax; the dorsal segments with black transverse bands; the sheath of the ovipositor brownish.

The ♂ is similar; the black on the pleuræ is more extended, extending all over except under the tegulæ and on a large oblique mark on the middle behind; on the antennæ the black extends on to the base of the third joint.

ALLOMORPHA PULCHRIPES, *sp. nov.*

Nigra, late albomaculata; antennis nigris, basi testaceis,

apice albis; pedibus rufis, coxis, trochanteribus tarsisque albis; basi tarsorum posticorum nigro; alis hyalinis, stigmate fusco, basi pallido. ♀.

Long. 8 mm.

Antennæ as long as the thorax and abdomen, not tapering towards the apex; the basal two and the base of the third joint testaceous; the apex of the sixth and the following joints clear white; the rest black; the second, third, and fourth joints equal in length and distinctly longer than the apical. Head black, shining, impunctate; the labrum, clypeus, mandibles, and palpi clear white; the mandibular teeth black. The front raised; shallowly depressed in the middle at the top; the lower part deeply, the apex of the clypeus widely, depressed. Thorax shining, impunctate, a line on the pronotum, the apex of the middle lobe of the mesonotum, the scutellum, the upper part of the mesopleuræ at the base, its apex narrowly and a large oblique mark in the middle towards the apex, white. Mesonotum impunctate, closely covered with short, black hair; the furrow on the middle lobe is narrow, complete; the scutellum rather flat; the depression at its base large. Wings clear hyaline, the stigma pale at the base; the recurrent nervures are received in the same distance from the base of the cellules within their basal third; the median nervure is received in the middle of the cellule; the accessory nervure in the hind wings interstitial. Legs rufo-fulvous, the hinder darker in tint; the coxæ and trochanters white; the base of the hind tarsi broadly black; the apex of the fourth and the other joints white; the claws ferruginous, bifid; the calcaria rufous. Abdomen black, shining; the apices of the segments, narrowly, the apical two entirely, white; the ventral surface whitish, except on the apical two segments.

TAXONUS FULVIPES, *sp. nov.*

Niger, abdomine late testaceo-balteato; pedibus testaceis, anticis pallidis; alis fusco-hyalinis, nervis stigmateque nigris. ♂.

Long. 6 mm.

Antennæ about as long as the abdomen, thickly covered with short, black hair; the third and fourth joints are about equal in length. Head shining, above thickly covered with short, black, the face thickly with longer fuscous hair; the labrum with still longer pale hair; the palpi pale testaceous; the incision in the clypeus rounded, not very deep; its sides almost triangular. Thorax black, an irregular white mark on the mesopleuræ behind; the mesonotum and scutellum minutely punctured, thickly covered with short, black hair; the pleuræ and sternum more sparsely with white pubescence. The radial nervure is received shortly beyond the middle of the cellule; the second cubital cellule is slightly longer than the third; the recurrent nervures are received distinctly in front of the middle of the cellule; the transverse basal nervure is received beyond the middle of the cellule. In the hind wings the humeral nervure is interstitial. On the abdomen the basal, the sides of the second segment at the base and the apical three segments, with the sheaths of the ovipositor, are black. The front coxæ and trochanters are white, the femora and tibiæ pallid-fulvous, the tarsi at the apex infuscated; the four anterior legs are not so pallid at the base; the apex of the tibiæ and the tarsi blackish; the claws are simple.

Appears to be a true *Taxonus*, the first recorded east of Europe. The nervure in the lanceolate cellule is not quite so oblique as it is in the typical species of *Taxonus.*

RETHRAX. *gen. nov.*

Eyes converging beneath, not reaching to the base of

the mandibles, the front broad, depressed; the eyes margined behind. Antennæ of medium length, not much longer than the abdomen; the third joint slightly longer than the fourth. Scutellum raised; its centre stoutly longitudinally keeled throughout. Blotch indistinct, patellæ distinct; the claws bifid. Wings as in *Tenthredo*; the humeral nervure in the hind wings received beyond the transverse discoidal.

Differs from *Tenthredo* in the eyes converging beneath and in not reaching to the base of the mandibles. The antennæ are longer than in *Rhogogastera*, and with the third joint shorter compared with the fourth. The principal feature, however, of the genus lies in the very strongly keeled scutellum, a structure which does not occur in any known species of the *Tenthredinides.* The pleuræ are straight, not rounded on the lower side, the edge at its junction with the sternum being distinctly margined; the orbits behind have a sharp keel above but not on the extreme outer edge. The parapsidal furrows are not very distinctly defined. The fore calcaria are rather peculiar, they are straight above; the apex much narrowed and sharp; before it is a large, acute, straight projection, much larger than usual.

RETHRA CARINATA, *sp. nov.*

Nigra; capite thoraceque punctatis, ore pedibusque flavis, geniculis, tibiis tarsisque posticis nigris; alis fulvo-hyalinis, nervis stigmateque nigris. ♀.

Long. 11 mm.

Antennæ black; the scape sparsely pilose; the flagellum almost glabrous. Front and vertex punctured, the vertex finely and closely, the front coarsely, especially in the middle, but the sides of the front at the apex are smooth and shining; the front depressed in the middle,

more broadly behind. Clypeus, labrum, mandibles, and palpi yellow; the mandibular teeth black. Thorax black, a broad band on the pronotum and the tegulæ lemon-yellow. Mesonotum opaque, closely punctured; the furrow on the middle lobe distinct. Scutellum pyramidal; more strongly punctured than the mesonotum, the middle stoutly keeled throughout, the basal and apical (or lower) part of the keel separated by a curved depression. Pleuræ opaque, closely and uniformly punctured; the sternum closely punctured, finely furrowed down the middle; the sides bluntly margined. Abdomen entirely black, without any yellow; the back with a distinct violet-blue tinge, smooth and shining. Legs straw-yellow; the apex of the four anterior femora above, the four anterior tibiæ behind, all the tarsi and the hinder knees and tibiæ, black; the patellæ are distinct; the claws are bifid.

PACHYPROTASIS VIOLACEIDORSATA, *sp. nov.*

Flava, supra nigra; tibiis tarsisque anterioribus postice, apice femorum, tibiis tarsisque posticis nigris; alis hyalinis, stigmate nervisque nigris. ♀.

Long. 8 mm.

Antennæ black, the scape yellow beneath; the vertex and the greater part of the front above, and the occiput, black; on either side of the vertex is an oblique yellow mark, triangularly narrowed on the lower side and touching the eyes; the apex of the labrum almost transverse. The upper part of the body black, except the apex of the middle lobe of the mesonotum, a mark between it and the scutellum, the scutellum and post-scutellum; the sides and under surface pale yellow, except the upper part of the pronotum and of the mesonotum, except at the apex; there is a small black mark on the sides of the mesosternum. The four anterior tibiæ and

tarsi are lined behind with black; the apex of the hinder femora above, and the hinder tibiæ and tarsi, entirely black. The dorsum of the abdomen has a distinct bluish tinge.

It comes near to *P. albocincta* Cam., from the Himalayas (*Trans. Ent. Soc., 1881, p. 565*), but that is distinct.

BELDONEA, *gen. nov.*

Wings with two radial and four cubital cellules; the basal nervure received distinctly before the base of the cubital Lanceolate cellule divided into two unequal parts through the humeral nervure touching the brachial nervure. Hind wings with two cubital cellules; the accessory nervure appendiculate. Antennæ short, thickened before the apex; the third joint is twice the length of the fourth. Eyes large, parallel, reaching close to the base of the mandibles. Clypeus transverse, or nearly so; the labrum large, rounded at the apex. Mandibles large, acutely pointed at the apex; when closed their apices reach to the side of the clypeus. Legs of normal size; the calcaria short, not much more than one-fourth of the length of the metatarsus, which is distinctly longer than all the other joints united. The claws are bifid; the anterior calcaria are sharp, simple. Abdomen short.

The relationship of this genus is clearly with *Siobla* and *Strongylogaster*, from both of which it may be known by the form of the lanceolate cellule; in *Siobla* it is open, not divided into two parts by its nervure uniting with the one above, there being further no oblique cross nervure, the same remark applying to *Strongylogaster*. Comparing it with the typical *Strongylogaster*, *e.g.*, with *S. cingulatus*, it is seen to have the abdomen shorter and thicker, the antennæ more thickened beyond the middle, and with the third joint clearly longer compared with the fourth; and

further, the basal nervure is not joined to the cubital. The three characteristic features belonging to it are the antennæ thickened beyond the middle, and with the third joint much longer than the fourth; the contracted lanceolate cellule and the long metatarsus. The third and fourth joints of the hinder tarsi are acutely produced at their apices.

BELDONEA RUGIFRONS, *sp. nov.*

Nigra; thorace rufo; medio antennarum, coxis, trochantidibus dimidioque basali tibiarum posticarum albis; alis hyalinis, fascia substigmatali fusca. ♀.

Long. 8 mm.

Head black, the vertex with a purple tinge; thickly covered with short, pale pubescence; the face and clypeus with the hair longer and thicker; the front rugosely punctured, most strongly in the middle, which is raised and separated from the sides. The vertex behind the ocelli raised; bounded laterally by a wide and deep furrow; the lower part, and between the ocelli, rugosely punctured; the punctuation on the upper part not so strong, and there is a distinct keel down the middle; the oral region smooth, densely covered with long, white hair; the apical half of the mandibles piceous; the palpi pale black at the base. Antennæ not much longer than the thorax, distinctly thickened towards the apical joint which is itself slightly attenuated and longer than the preceding; the first, third, fourth, and fifth joints white; the third joint is almost twice the length of the fourth. Thorax closely punctured above; the mesopleuræ coarsely, rugosely punctured; the breast smooth; its central furrow wide and deep at the apex; the middle lobe of the mesonotum widely furrowed at the base; the scutellum rugosely punctured; the metanotum widely depressed in

the middle. Wings large, hyaline, a large, dark smoky cloud between the base and apex of the stigma and extending into the discoidal cellule; the radial nervure is received shortly beyond the middle of the cellule; the recurrents in the basal thirds, as is also the transverse median. Legs black, covered with white hair; all the coxæ and trochanters, the apex of the anterior femora and the base of the tibiæ in front and the basal half of the hinder tibiæ, the apex of the first broadly and the second joint of the hinder tarsi, white; the spurs short, not one-fourth of the length of the metatarsus, which is longer than the succeeding joints united; the claws are bifid. Abdomen as long as the head and thorax united, black; the second segment white; the basal segment has a metallic-blue tinge.

BUSARBIA, *gen. nov.*

Antennæ nine-jointed, long, filiform, the third and fourth joints equal in length; eyes parallel, not reaching to the base of the mandibles. Mandibles large, their apical tooth long. Apex of the clypeus roundly incised, oblique. The frontal area large, transverse at the apex, rounded and slightly narrowed at the base, where it encloses the anterior ocellus; the keels bounding it are large, acute, and from their apices at the sides a keel unites them to the eyes; the front is raised above the antennæ, the raised part obliquely depressed at the top. Occiput not margined. Wings with two radial and four cubital cellules; the lanceolate cellule open, without a cross nervure; the hinder wings with two cubital cellules, the accessory nervure appendiculated, the basal nervure is received distinctly in front of the cubital, as in *Tenthredo.* Legs moderately slender, the claws unequally bifid; the calcaria short, not one-fourth of the length of the metatarsus.

This genus has the neuration of *Siobla* or *Selandria*, except that in the latter the basal nervure is united to the cubital. It differs markedly from both in the long, slender antennæ, in the incised apex of the clypeus, in the frontal area being sharply and clearly bounded by distinct keels, and in it being united to the eyes by a keel. The wings are rather longer than usual, the costa is not so much dilated before the stigma as in *Selandria*, the sutures on the vertex are distinct, narrow, but deep; the head moderately developed behind the eyes, but not quite so much so as in *Siobla*. It is further a much more slenderly built insect than *Siobla* or *Selandria*, more like *Stromocerus*.

BUSARBIA VIRIDIPES, *sp. nov.*

Nigra; scapo antennarum, linea pronoti, tegulis maculaque mesopleurali albis; pedibus pallide viridibus. ♀.

Long. fere 6 mm.

Antennæ filiform, longer than the abdomen, black; the basal joint white; the flagellum covered with short, stiff, black pubescence; the third and fourth equal in length. Head black, the clypeus, labrum, the base of the mandibles broadly, and the palpi, white; shining, impunctate; the frontal area with some obscure striæ. Thorax shining, impunctate; the hinder part of the pronotum broadly, the tegulæ, a large oblique mark on the hinder part of the mesopleuræ—broad at the base, gradually narrowed towards the apex—clear white. Wings large, hyaline, the nervures black, the lower part of the stigma fuscous. The second cubital cellule is distinctly longer than the third; and receives the recurrent nervure near to the apex; the second shortly before the middle of the cellule; the basal nervure shortly before the middle; the radial nervure curved above, its lower part almost perpendicular.

Legs uniformly greenish white, except the apices of the tarsi which are blackish. Ventral surface, except at the apex, pale fulvous-testaceous, perhaps discoloured.

The colour of the legs when the insect was alive was probably of a bright, delicate green, which has doubtless faded, as does the green of *Strongylogaster delicatulus* Fall., with age.

SUNOXA, *gen. nov.*

Head scarcely developed behind the eyes, the front and vertex forming one piece without a suture; the frontal area obsolete. Mesonotum trilobate. Legs stout; the hinder coxæ large; the basal joint of the hinder tibiæ dilated, hollowed on the outer side; about two-thirds of the length of the hinder tibiæ and twice the length of the other joints united; the second as long as the third and fourth united, stout; the last as long as the preceding two united; the patellæ obsolete; the claws with two unequal teeth. The basal nervure is united to the cubital; there are two cubital cellules in the hind wings.

Belongs to the *Selandriades* and comes near to *Siobla* and *Strongylogaster* with which it agrees in the alar neuration, but differs markedly in the head not being developed behind the eyes and in the great length and size of the metatarsus, which is longer in proportion to the other joints than in any genus known to me. Unfortunately the antennæ are broken off.

SUNOXA PURPUREIFRONS. *sp. nov.*

Lutea; capite caeruleo, ore fulvo-testaceo; femoribus, apice tibiarum tarsisque posticis nigris; alis fusco-violaceis.

Long. 6? mm.

Head small, dark purple, the clypeus, labrum, mandibles, except their teeth, and palpi pale fulvo-testaceous.

The front and vertex strongly and uniformly punctured; except the sides of the vertex where it is smooth and dull brownish outside the furrows, which are deep behind the ocelli, obsolete at their sides; on the front, shortly above the antennæ is a smooth conical fovea; the clypeus is finely punctured, transverse at the apex, the sides oblique. Thorax smooth, shining, impunctate; the mesonotum thickly covered with short, black hair. The radial nervure is received in the apical, the recurrent nervures in the basal, fourth of the cellules; the transverse humeral in the basal third. Legs coloured like the thorax, but paler, more yellowish, especially the front pair, the hinder femora and tibiæ, except at the apex, and the hinder tarsi black with a purplish tinge, the middle tarsi fuscous. Abdomen with the basal segments luteous; the apex broken off.

EMPHYTUS PILIFRONS, *sp. nov.*

Niger, capite dense hirsuto; basi antennarum, orbitis oculorum, linea pronoti clypeoque rufis; pedibus nigris, basi tibiarum albo; alis hyalinis, apice fumatis. ♂.

Long. 8-9 mm.

Antennæ dull black; the scape and second joint clear fulvous; the flagellum brownish beneath, thickly covered with short, stiff hair. Head black, thickly covered with short, pale hair; the vertex shining, the front opaque, granular; the keels on the vertex deep, curved; the clypeus at the base broadly, the inner orbits, a mark behind the eyes near the hinder edge, fulvous; the apex of the clypeus obliquely depressed, roundly incised and brownish; the labrum large, rounded at the apex, pale testaceous and fringed with long, white hair; the palpi blackish. Thorax black; the edge of the pronotum broadly, the lower edge of the propleuræ and the tegulæ, fulvous. The middle lobe of the mesonotum opaque,

finely rugose; the lateral smooth and shining. Scutellum coarsely rugosely punctured. Mesopleuræ opaque, thickly covered with short, white hair, obscurely rugose above. Abdomen black; the basal three segments in the middle above, more or less at the sides and the ventral surface entirely, white; the other segments narrowly white at the apex, the apical broadly so. Legs black, thickly covered with pale pubescence; the anterior tibiæ almost entirely, and the bases of the hinder four, white. Wings hyaline; the costa and stigma testaceous; the radial cellule, the upper part of the cubital cellules, except the base of the first, smoky; the transverse basal nervure interstitial.

EMPHYTUS MACULIVENTRIS, *sp. nov.*

Niger; tibiis anticis abdomineque subtus albis; alis hyalinis, apice fumatis. ♀.

Long. 9 mm.

Antennæ black, the middle joints thickened. Face closely and rather strongly punctured; the clypeus smooth, above forming a semicircle, its edge projecting; the labrum large, smooth and shining, rounded; the face and clypeus covered with long, pale hair. The middle lobe of the mesonotum is finely rugose, furrowed down the middle, and thickly covered with short, black hair; the lateral lobes finely punctured, less pilose and more shining. Scutellum pyramidal, brought to a point in the middle above; coarsely rugosely punctured; the part behind the cenchri obliquely depressed; the sides of the depression carinate. Propleuræ rugose, smooth and shining at the base; the mesopleuræ, except on the lower side, coarsely punctured, the punctures large, round, and distinctly separated; the metapleuræ smooth. Legs thickly covered with white hair, especially thick on the tibiæ and tarsi; the spurs and claws rufous; the claws

bifid, the joints sub-equal. The cloud in the fore wings occupies the whole of the radial cellule, the first cubital, except an oblique corner at the base, the upper half of the second, and a narrow band on the top of the third. The upper part of the second and third abdominal segments, narrowly in the middle, and their sides more broadly, white, the marks on the sides being narrowed at the top.

EMPHYTUS RUFICEPS, *sp. nov.*

Brunneus nigro-maculatus; apice antennarum nigro; pedibus pallidis; femoribus apiceque tibiarum posticarum nigris; alis fere hyalinis, apice fumatis, stigmate ochraceo. ♀.

Long. 10 mm.

The scape of the antennæ pallid white; the second, third, fourth, and the base of the fifth joints reddish-testaceous; the apical joints black. Head rufous; the labrum, the inner orbits, a mark above each antenna and the outer orbits, except at the top, whitish-yellow; the space between, above in the middle, and the entire surface below them, black. The clypeus is closely punctured; its apex has a semicircular incision, and is obliquely depressed; the labrum is smooth. The front is closely and rather strongly punctured; its raised central part broadly margined with black, which is continued between the hinder ocelli; the vertex is less strongly punctured; the middle slightly raised, the raised part bordered by narrow, but distinct, furrows; the lower part of the occiput is black. The middle lobe of the mesonotum is black, except at the sides and apex; and is furrowed down the centre; the lateral lobes are black at the apices; the parapsidal furrows are wide and deep. Scutellum roundly convex; the apex with a longer slope than the base. The postscutellum depressed at the base,

smooth, yellow, as are also the lateral keels. Pleuræ coarsely punctured, thickly covered with short, white hair; the propleuræ black, rufous above, pallid yellow below. Mesopleuræ rufous, marked with yellow on the lower part; the base, apex and the mesosternum, black. Metapleuræ black. Legs pale testaceous; the fore coxæ black at the base, the hinder pair black below; the four anterior femora marked broadly with black above; the four hinder tibiæ broadly at the apex all round and above the middle behind; the tarsi are dark testaceous; the claws are bifid. The radial cellule is entirely brownish-smoky, the smoky tint extending on to the top of the cubital cellules. The basal half of the median segment black, the apical yellowish, deeply furrowed down the middle; the other segments black, yellowish testaceous on their apices; the last segment entirely so; the sheath of the ovipositor pallid yellow.

SELANDRIA PILICORNIS, *sp. nov.*

Nigra, abdominis basi late testaceo; coxis, trochanteribus, tibiis anterioribus basique tibiarum posticarum albidis; alis fumatis, basi fere hyalinis. ♀.

Long. 10 mm.

Antennæ as long as the head and thorax united, thickly covered with long, stiff, black hair; the third joint is slightly, but distinctly, longer than the fourth. Head large, largely developed behind the eyes, but not projecting beyond them; shining, impunctate, thickly covered with fuscous hair, and with a bluish violet tint; there is no frontal area, nor any furrows or depressions on the vertex. Clypeus strongly punctured, the apex transverse, the sides rounded; labrum white, thickly covered with long, white hair; mandibles piceous in the middle; the palpi black, covered with white hair. Thorax shining, impunctate,

covered thickly with moderately long, fuscous hair; at the base of the scutellum is a wide and deep semicircular depression. All the coxæ and trochanters are white; the tibiæ are for the greater part white behind; all the legs thickly covered with short, white hair; the claws are bifid. The second cubital cellule is shorter than the third; the first transverse cubital nervure is faint; the transverse basal nervure is received the length of the first transverse cubital nervure from the cubital; the first recurrent in the middle. In the hind wings the humeral nervure is received beyond the transverse brachial, nearer the apex. On the abdomen the apex of the first, the second to fourth, and the greater part of the fifth segments are testaceous.

SELANDRIA FUSCINERVIS, *sp. nov.*

Nigra; coxis, trochanteribus, basi tibiarum late tarsisque anterioribus albis; alis hyalinis, stigmate nervisque fuscis. ♀.

Long. 9 mm.

Antennæ short, stout, distinctly tapering towards the apex, thickly covered, especially at the base, with short, stiff, black pubescence, the third joint is distinctly longer than the fourth. Head shining, impunctate, the front and vertex thickly covered with fuscous, the face with longer, paler hair; that on the labrum being the longest; the frontal area obsolete; the furrows on the vertex distinct, except at the base; above the antennæ is a deep fovea, broader than long, rounded at the base and sides, more transverse at the apex; the sides oblique. Apex of clypeus transverse, its sides rounded; the mandibular teeth piceous; the palpi fuscous-black, covered thickly with pale pubescence. Mesonotum shining, impunctate, thickly (especially at the base) covered with fuscous pubescence. Pleuræ shining, the apex of the propleuræ rough. Legs black; the apex of the coxæ, the trochan-

ters, the base of the four anterior coxæ, the apex of the posterior pair more broadly, especially behind; the base of the four anterior tibiæ, and the hinder, except at the apex, white; the tarsi fuscous; the claws are bifid. The second cubital cellule is nearly as long as the third; the first transverse cubital cellule is almost obliterated; the first recurrent nervure is received in the basal third; the second quite close to the second transverse cubital nervure, in one example almost united to it.

SELANDRIA CAERULEICEPS, *sp. nov.*

Caerulea, abdomine nigro; linea pronoti, coxis, trochanteribus basique tibiarum late albis; alis hyalinis, nervis stigmateque nigris. ♀.

Long. 8 mm.

Antennæ short, distinctly tapering towards the apex; black, thickly covered with short, stiff hair. Front and vertex shining, smooth; frontal area obsolete; the furrows bordering the ocelli distinct but shallow; a depression before the anterior ocellus; the vertex bordered by a furrow in front. Clypeus strongly and closely punctured, bluish-coppery in tint; the labrum white; both are thickly covered with long, white hair; the mandibles are piceous before the teeth; the apices of the palpi pale. Thorax shining, impunctate, thickly covered with short pubescence. Wings almost hyaline, the stigma and nervures black; the first transverse cubital nervure is obliterated at the base; the second cubital cellule is, if anything, longer than the third, and receives the recurrent nervure shortly before the middle; the second is received near the base of the cellule; the transverse radial nervure is received in the apical fourth of the third cubital cellule; the transverse humeral nervure shortly beyond the middle; the accessory nervure in the hind wing is almost inter-

stitial. Legs thickly covered with white pubescence; the coxæ, trochanters, knees and the base of the tibiæ white; the calcaria testaceous; the claws bifid, but unequal in length. The cenchri large; the part between them semicircularly depressed.

ERIOCAMPA PUNCTATA, *sp. nov.*

Nigra; capite thoraceque punctatis; alis fumatis. ♂.

Long. 10-11. mm.

Antennæ as long as the abdomen, stout, covered with a microscopic pile; the third joint twice the length of the fourth. Front and vertex strongly punctured, the frontal area horseshoe-shaped; the bounding keel large, broad, punctured, extending behind the front ocellus; the vertex behind the ocelli raised, the raised part distinctly margined; the occiput sharply margined, projecting into a short tooth behind the vertical furrow. The clypeus is closely and strongly punctured as is also the labrum; both are bluntly rounded at the apex; the head above the antennæ is thickly covered with short, fuscous, below with longer, white hair. Mesonotum shining, strongly, but not closely or coarsely, punctured; the scutellum with the punctures equally large but more widely separated; the metanotum closely and strongly punctured, widely and deeply depressed at the base. Legs black, the calcaria paler; the claws bifid, rufous; the tibiæ and tarsi thickly covered with pale pubescence; the inner spur of the anterior calcaria is dilated at the apex, and ends in two spines, the inner being broader and shorter than the outer. The third cubital cellule is longer than the second, the first recurrent nervure is received shortly before the middle, the second not far from the base of the cellule; the transverse median is received near the basal nervure. Abdomen smooth and shining. On the legs the patellæ are large and well developed; the blotch is small.

A distinct species. Is perhaps not a true *Eriocampa*. In the latter the clypeus is deeply incised, the transverse basal nervure is received quite close to the base of the radial nervure, while in the present species it is much more widely removed from it, and the clypeus is transverse at at the apex.

Obs. I described (*Trans. Ent. Soc.* 1876, p. 461) a *Monophadnus bengalensis* from Bengal which Mr. Kirby (*List of Hymen.* i., p. 185) states is an *Eriocampa*. If so, his figure (*pl.* viii. *f.* 17) is wrongly drawn, for the fore-wing is that of a *Monophadnus*, not of an *Eriocampa*. On the same plate (*fig.* 9) Mr. Kirby figures a *Monophadnus lineatus*, from Hudson's Bay, which is certainly an *Eriocampa*, if the figure is correct.

ERIOCAMPA MAJOR, *sp. nov.*

Long. 13 mm.

Agrees in coloration with *E. punctata*, but may readily be separated from it by the head not being narrowed behind the eyes, by its being behind almost transverse, not distinctly concave, and by the eyes not converging so much below.

Head rugosely punctured, thickly covered with short, white hair on the vertex, with longer hair on the face and clypeus. The vertex behind the ocelli raised and separated from the sides; its centre with a fine, longitudinal keel. Clypeus projecting; its apex bluntly rounded; the labrum smooth, brownish, thickly covered with long, pale hair; the palpi are fuscous. Behind the eyes the head is rounded, but not narrowed; it is there nearly as long as the eyes. Mesonotum closely punctured, thickly covered with short, white hair; the middle lobe is more shining than the lateral, and finely furrowed down the middle. Scutellum rounded; its basal half smooth, very shining, with hardly any punctures; its apical half rugosely punctured, opaque, and covered with long, pale hair. Metanotum rugosely punctured; the cenchri cream-

coloured. Pleuræ opaque, closely punctured; the sternum shining, and not quite so strongly punctured. Abdomen shining, smooth, the apical segment pale testaceous. Wings uniformly fuscous-hyaline; the nervures and stigma black; the first recurrent nervure is received shortly beyond the middle; the second quite close to the second transverse cubital nervure. Legs black, the fore femora and tibiæ in front for the greater part fusco-testaceous; the patellæ are well developed; the claws bifid.

The antennæ are absent. The species is very large for an *Eriocampa*, but does not appear to be separable from it.

MONOPHADNUS LATICARINATUS, *sp. nov.*

Niger; prothorace, mesonoto cum scutello, mesopleurisque sanguineis; coxis, trochanteribus femoribusque posticis subtus albis; alis fumatis. ♀.

Long, fere 6 mm.

Antennæ short and thick, thickly covered with short, stiff, black hair; the third joint about one-quarter longer than the fourth. Head black, shining; the pentagonal area clearly defined; its apex widened and round, and not so clearly limited as the sides; between it and the antennæ is a large area with thick walls; it is slightly wider than long, and has a keel down the middle. The clypeus is shining, its apex rounded; the labrum is fringed with long, white hair; the palpi long, black, covered with a pale down. Thorax shining, impunctate, thickly covered with pale pubescence; the parapsidal furrows deep; the middle lobe is deeply furrowed except at the apex. Legs black; all the knees, the hinder coxæ, trochanters, femora, except above, and the base of the hinder tibiæ, white. Wings fuscous, the stigma and nervures black; the trans-

verse radial nervure is received shortly, but distinctly, beyond the middle of the cellule; the first recurrent nervure is received almost in the middle; the second distinctly before the middle of the cellule. Abdomen shining, glabrous; the sheath of the ovipositor thickly covered with short, pale hair; its lower side has a distinct curve from the apex to beyond the middle.

MONOPHADNUS DILUTIPENNIS, *sp. nov.*

Niger; geniculis tibiisque late flavis; alis fusco-hyalinis, stigmate testaceo. ♀.

Long. 6 mm.

Antennæ short, thick, as long as the head and thorax united, thickly covered with short, black pubescence. Head thickly covered with short, black hair; the ocellar area somewhat horseshoe-shaped, open in front, the bounding keels broad, distinct; it is raised, and, laterally, is bounded by a deep and wide furrow; the front with a short, stout keel above each antenna; the space between them depressed, and with a broad aciculated keel in the middle. Clypeus shining, its apex rounded; covered, but not very closely, with minute punctures, and thickly with longish, black hair; the labrum is brownish, closely punctured. Thorax shining, impunctate; the mesonotum thickly covered with short, black hair. The metanotum forms a semicircle, and is widely depressed; the cenchri being inside the depression. Legs thickly covered with white down; all the knees, the basal third of the front tibiæ, the basal half of the middle pair and the hinder, except at the apex, white. The stigma is large; it and the costa are testaceous; the nervures are of a darker tint; the first recurrent nervure is received in the middle, the second in the basal third of the cellule. Abdomen black and shining; pubescent towards the apex; the

sheaths of the ovipositor covered at the apex with long, white hair.

PROCTOTRUPIDÆ.

EPYRIS FUSCINERVIS, *sp. nov.*

Nigra, nitida; geniculis, tibiis tarsisque testaceis; alis fusco-hyalinis, costa nervisque testaceis; antennis nigris, basi flagelli testaceo. ♀.

Long. 4 mm.

Hab. Barrackpore (*Rothney*).

Antennæ stout, the apex of the scape, the base of the flagellum distinctly, its middle indistinctly, testaceous; the scape roundly curved on the under side. Head shining, impunctate; the antennal tubercles testaceous. Prothorax not quite so long as the head; the collar obscure testaceous, shagreened, shining. Mesonotum shining, minutely and not very distinctly punctured; a narrow, but distinct, furrow down the sides opposite the sides of the scutellum, which is shining, impunctate, and with a wide, moderately deep and slightly curved furrow at its base. Median segment closely punctured, most strongly at the base, becoming weaker towards the apex; down its centre runs a distinct keel which reaches the apex of the basal part; on either side of this is a narrower, less distinct, keel which reaches to about the middle only; the apex is sharply oblique. Legs stout, the four anterior knees, tibiæ and tarsi, the posterior trochanters, the posterior tibiæ and tarsi dark testaceous; the four hinder femora are obscure testaceous in the middle, as are also the trochanters. Abdomen shining, the apices of the second and following segments, and nearly the whole of the last, testaceous. The first basal cellule is sharply oblique, the second (and lower) rounded at the apex.

Appears to be a true *Epyris*; but the parapsidal

furrows are only visible with a good lens. It is much smaller than the two described species which are both 10 mm. in length.

EVANIIDÆ.

EVANIA.

Only one species of this genus has been recorded from Continental India—*E. antennalis* West., from Bombay. It, and the two species here described, may be separated by means of the following table:—

1. (2) Legs and body entirely black; metasternal process widely diverging at the apex; the front distinctly keeled in the middle. *E. antennalis* West.
2. (1) Legs and body not entirely black; metasternal process not widely diverging; legs marked with white.
3. (4) Thorax red; base of flagellum white; face with two oblique keels running from the eyes. *E. curvicarinata.*
4. (3) Thorax and base of flagellum black; face not keeled. *E. albitarsis.*

EVANIA CURVICARINATA, *sp. nov.*

Nigra; facie alba, thorace rufo; annulo antennarum, basi tibiarum trochanteribusque albis; tarsis posticis fuscis, basi albis; alis hyalinis. ♀.

Long. 6-7 mm.

In coloration comes near to the Ceylonese *E. erythrosoma*, but that differs from it in many respects, *e.g.*, in having the face longitudinally striated and keeled down the middle, and in wanting the oblique lateral keels found in the present species.

Antennæ stout, black; the basal two joints of the flagellum for the greater part white, except on the apex of the second, which is black all round; the third joint is

as long as the scape and distinctly longer than the fourth. Head black, smooth, shining, impunctate; the eyes on the inner side very slightly diverging beneath; from shortly below their middle a distinct keel runs obliquely to the basal third of the clypeus; the face in the middle flat, neither furrowed nor keeled. Mandibles before the teeth reddish, below fringed with whitish hair; the palpi fuscous-testaceous. Thorax rufous; the apical three-fourths of the median segment and the metasternum, black. Mesonotum blackish in the middle near the apex; the middle shagreened; the sides minutely punctured; the furrows straight, oblique, converging at the apex, not reaching to the base of the scutellum, which is closely and finely punctured. Median segment strongly reticulated, except a small semicircular, finely punctured, space at the base; and the base of the metapleuræ which is closely and obliquely striated, especially below; the centre on the upper side is smooth and impunctate. The pro-sternum is black and impunctate; the meso- rufous like the rest of the thorax; the base irregularly transversely striated, bearing large, round, deep punctures, and furrowed down the middle; the metasternum has on either side a curved keel, and there is a straight one down the middle; the metasternal process short, triangular, very slightly diverging at the apex; but through their triangular form the apices are widely separated. Wings hyaline, the stigma black; the nervures fuscous, the apical paler; the cubital nervure obliterated beyond the first transverse cubital nervure; the second transverse cubital nervure obliterated; the only recurrent nervure is nearly interstitial. All the trochanters are white; the front femora are black, except at the base and apex; the fore tibiæ are obscure fusco-testaceous; the middle tibiæ and tarsi blackish; the base of the hinder tibiæ and the metatarsus, white; the hinder coxæ are

closely transversely punctured, more strongly at the base than at the apex; the long spur of the hinder calcaria reaches near to the middle of the metatarsus; the tarsi have no spines. Petiole with a few large punctures; its apex broadly white; the rest of the abdomen very smooth and shining.

EVANIA ALBITARSIS, *sp. nov.*

Nigra; facie, tarsis, trochanteribus, annulo tibiarum posticarum apiceque petioli albis; alis hyalinis. ♀.

Long. 7 mm.

Antennæ brownish, testaceous beneath, fuscous above, darker towards the apex; the scape on the under side thickly covered with longish white hair; the flagellum with a sparse microscopic down. The face from below the antennæ, a triangular space above them touching the eyes, the mandibles and the palpi yellowish-testaceous; the top below the antennæ and the part immediately below the eyes fulvous, thickly covered with white hair; the fulvous-coloured space below the antennæ rather strongly punctured; slightly projecting, narrowed slightly and gradually towards the apex, where it is transverse. Mandibles strongly toothed, the teeth black. The hinder ocelli are separated by about the same length from each other as they are from the eyes; immediately behind them is a distinct, straight, moderately deep, transverse furrow. Thorax entirely black; the mesonotum shining, obscurely punctured; its middle lobe distinctly separated from the lateral; raised at the base; narrowed towards the apex; the dividing furrows deep; the transverse furrow at the base of the scutellum deep, and extending, slightly obliquely, beyond the lateral ones. Scutellum obscurely punctured, thickly covered with fuscous hair; at its base is a narrow, oblique furrow. The base of the median

segment is oblique; obscurely punctured; the sides at the base distinctly and strongly reticulated, this being also the case under the petiole; the apex closely punctured, the punctuation running into indistinct reticulations. The lower part of the propleuræ strongly irregularly striolated, distinctly margined at the base and apex; the upper part of the mesopleuræ smooth in the middle; the posterior half raised; the base of the raised part crenulated; the basal part of the lower region bearing large, deep, round, distinctly separated punctures; the punctured part of the mesonotum is separated from the upper and basal by an oblique furrow. The anterior legs are pale testaceous, except the coxæ which are black and the middle femora which are infuscated; the hinder coxæ are black, strongly punctured on the basal half, the apical part closely striated in the middle above; the sides and lower part thickly covered with white hair; the hinder trochanters white, broadly black at the apex above; the four anterior tarsi are slightly infuscated; the posterior clear white; the spurs are black; the longer spur reaches near to the middle of the metatarsus; the extreme base of the hinder femora is black before the white band. Wings hyaline, the nervures black, except the apex of the radial which is pale; the second transverse cubital nervure is only indicated at the top; the recurrent nervure almost touches the apex of the first transverse cubital. Abdomen black; the apex of the petiole broadly white; the apical segments obscure testaceous; the petiole obscurely punctured. The base of the mesosternum is strongly transversely striolated and oblique; its centre is strongly furrowed; the sternum between the four hinder legs is strongly irregularly striated on the apical half; the middle depressed and with a narrow keel down it; the metasternal processes are short, thick, nipple-like, and hardly

diverging at the apices. The hinder tarsi are slightly spined.

AULACUS BITUBERCULATUS, *sp. nov.*

Niger; pronoto mesonotoque cum scutello rufis; alis hyalinis, fusco-bifasciatis. ♀.

Long. 15; terebra 14 mm.

This genus is an addition to the Hymenoptera of Continental India, although two species are known from Ceylon. These differ in many respects from *A. bituberculatus.*

Antennæ black, brownish towards the apex on the under side; the third joint of the length of the basal two united; the fourth as long as the second and third united. Head black; the vertex shining, bearing shallow, scattered punctures; sparsely pilose; the vertex near the edge behind has on either side a distinct, bluntly triangular tubercle. Front sparsely covered with short, white hair; a short, indistinct keel in front of the ocelli; the clypeus closely, shallowly, irregularly punctured; fringed at the apex with long, white hair. Mandibles piceous in the middle, the base opaque, closely rugose. Thorax coarsely rugose; the propleuræ, pronotum, mesonotum and scutellum rufous; the middle of the mesonotum coarsely, transversely striated. The sides of the scutellum smooth; the middle with a few, widely separated, stout, transverse striations; the apex of the scutellum is black. Median segment stoutly irregularly reticulated. Propleuræ irregularly and strongly rugose; the mesopleuræ opaque, irregularly, and not very strongly, rugose below; the oblique hollow over the middle coxæ striated, more distinct on the lower than on the upper part; the middle behind smooth, the upper irregularly reticulated; the lower part stoutly irregularly striated. Metapleuræ rugose, below

transversely striated. Legs black, the apex of the hinder tibiæ and the hinder tarsi fulvo-testaceous. Wings hyaline, the apex and a spot below the basal two-thirds of the stigma, extending on the lower side slightly beyond the cubital nervure, brownish; the nervures blackish; the first transverse cubital nervure fuscous, almost obliterated on the lower side; the second very faint, except at the top. Abdomen smooth, shining, the apex of the last segment pale; the petiole distinctly separated, three times as long as broad.

This species belongs to the small group, named by Westwood *Aulacinus*, distinguishing by having three complete cubital cellules. The first cubital cellule at the top is about one-third of the length of the top of the second; at the bottom the two are about equal in length; the recurrent nervure is received somewhat less than the length of the top of the first cubital cellule from the second transverse cubital nervure. The form of the discoidal cellule is also as in *Aulacinus*, *i.e.*, the first recurrent nervure is not united with the first transverse cubital nervure, but received considerably in front of it.

WROUGHTONIA, *gen. nov.*

Front depressed, in the centre immediately over the antennæ armed with a large, stout tooth, which is bluntly rounded at the apex. Labrum large, rounded. Mandibles stout, short, with one blunt, short upper tooth on the apex as seen from the inside. Eyes oval, not reaching to the base of the mandibles. Scutellum pryramidal. Metathorax elongate. Wings with two transverse cubital nervures and consequently two cubital cellules; the cubital nervure originates near the top of the transverse basal; the first recurrent nervure is received in the apical third of the first cubital nervure; the others are obliterated

entirely; the transverse median nervure is received shortly in front of the transverse basal. Abdomen shorter than the thorax; the petiole large, longer than the second segment, not much narrowed towards the base. Legs elongate, the hinder coxæ large; the hinder femora with a sharp tooth on the under side near the apex; the lower side behind the tooth with a rough edge.

This genus appears to me to be a valid one; possessing four good characters whereby it may be separated from *Aulacus*, namely (1) by the presence of a stout horn on the front, which is also more depressed in the centre and having the depression margined laterally by a blunt keel, (2) the pyramidal scutellum, (3) the much broader and shorter petiole, and (4) the spined hinder femora. Further points of differences are—the almost unidentate mandibles, which are also shorter and blunter; the antennæ placed higher up on the face, being situated opposite the middle of the eyes; the larger, hollowed postscutellum; the more elongated metathorax; the more elongated hinder coxæ; and the shorter abdomen.

The tuberculated head and the spined femora shows some relationship with *Megischus*, from which it is very different in other respects.

WROUGHTONIA CORNUTA, *sp. nov.*

Nigra, abdominis basi flavo; pedibus fulvis, apice femorum posticorum apiceque tibiarum posticarum late nigris; tarsis posticis albis; alis hyalinis, stigmate nervisque nigris. ♀.

Long. 8-9; terebra 9 mm.

The basal two joints of the antennæ rufous beneath; the base of the flagellum black, the other joints broken off. Head black, the front and vertex shining, smooth, glabrous; the face rugosely punctured; in the centre

above, coming from the base of the antennæ, are two keels which become stouter and converge, but do not unite, at the apex above the base of the clypeus, the two being united there by a stouter transverse keel. The clypeus is transverse at the apex; rounded at the base, the middle depressed. Mandibles short, thick, rufous in the middle; the apex with a depression in the centre. Palpi long, sparsely covered with short, pale hair; the basal joint of the maxillary black. Thorax black, shining; the base with a semiperpendicular slope; the middle lobe of the mesonotum raised, distinctly separated from the lateral at the base; the latter are more shining. Scutellum pyramidal, sharply pointed in the middle on the top; the base punctured, the sides with two or three stout keels. Post-scutellum depressed above, rounded at the apex, which is raised in the centre. The median segment elongate, the base distinctly separated from the apex of the mesonotum; in the centre are two stout keels, which enclose a smooth, shining, glabrous area, narrowed at the base, the sides strongly irregularly transversely striolated. Propleuræ stoutly, obliquely and widely striolated; the upper part finely and closely striated. Mesopleuræ smooth, shining, and glabrous; the base and apex crenulated; the upper part under the wings raised, the raised part finely and closely punctured, and gradually narrowed towards the apex. Metapleuræ coarsely reticulated; the base above depressed, thickly covered with long, white hair. Mesosternum shining, smooth, thickly covered with short, black hair; the central furrow broad, rather shallow, the apical half with some transverse keels. Wings hyaline with a very slight fuscous tinge; the two transverse cubital nervures have an oblique slope, and are both bullated on the lower side; the recurrent nervures are entirely obliterated. Legs fulvous;

the apex of the hinder trochanters, the extreme base of the hinder femora, their apical fourth deeply, and the apical third of the tibiæ, black, the black on the latter not so deep at the base; the tarsi pale. Abdomen black, shining; the petiole whitish-yellow.

GASTERUPTION MANDIBULARE, *sp. nov.*

Nigrum; mandibulis rufis; macula ad basin tibiarum posticarum rufo-testacea; alis hyalinis. ♀.

Long. 12-13; terebra 13 mm.

Antennæ as long as the head and thorax united, smooth, bare; the third joint shorter than the fourth, being about two-thirds of its length. Head opaque, the front and vertex alutaceous, almost glabrous; the hinder ocelli separated from each other by about the same distance which separates them from the eyes; the occiput with a narrow, sharp, distinctly separated border, which is pale on the outer edge; the face thickly covered with white pubescence; the mandibles rufous, the teeth black; the palpi blackish. Pronotum closely transversely striated, deeply furrowed down the middle. Mesonotum opaque, shagreened, bearing scattered, shallow punctures; the apex in the middle irregularly striated and punctured. Scutellum finely rugose; the sides above with a curved crenulated furrow; the sides below at the apex strongly longitudinally striated. Median segment under the petiole transversely striated, the striations at the base bent down in the middle; the apical ones somewhat stronger and more irregular. Propleuræ strongly shagreened; an oblique shallow furrow in the middle, which is striated behind; the mesopleuræ thickly covered with silvery pubescence; behind obliquely depressed, irregularly striated. Metapleuræ closely reticulated. Legs black; the extreme base and apex of the front

femora, the base of the four front tibiæ more broadly, and a band near the base of the hinder tibiæ, yellowish-testaceous; the hinder coxæ finely striated on the apex outside. Wings clear hyaline; the stigma pale testaceous below; the upper discoidal cellule long and narrow, the lower shorter and open below. Abdomen black, bearing towards the apex a pale down; the apex of the sheaths of the terebra annulated broadly with white.

BRACONIDAE.

CYCLOSTOMI.

BRACON.

A. *Abdomen greatly lengthened, over three times the length of the head and thorax united; cylindrical, the securiform articulation obsolete. Legs slender, the hinder not reaching to the apex of the abdomen; the wings much shorter than the abdomen.*

Apart from the form and extreme length of the abdomen there is no tangible difference between this species and *Bracon.* The legs are much more slender than is usual in that genus; the second cubital cellule is short, at the top not longer than the first at the bottom; the recurrent nervure is received in the apical fourth of the cellule, distinctly distant from the first transverse cubital.

BRACON LEPTOGASTER, *sp. nov.*

Capite, thorace, pedibusque anterioribus rufis; antennis, abdomine pedibusque posticis nigris; alis fusco-hyalinis, stigmate ochraceo; terebra corpore fere longiore. ♀.

Long. 23 mm.

Antennæ black, filiform, shorter than the abdomen, the scape covered with long, stiff, black hairs. Face yellowish, sparsely punctured, somewhat thickly covered

with fuscous hair; the clypeus rufous; mandibles yellow, rufous before the teeth, which are black; the palpi long, pilose, fulvous-yellow. Front and vertex shining; impunctate; the vertex and the upper part of the front broadly in the middle, black; the ocelli surrounded by a furrow, which is prolonged down the middle of the front; the occiput black in the middle, the black mark becoming gradually narrowed downwards. Thorax smooth and shining; the parapsidal furrows deep and wide; the apex of the scutellum and the post-scutellum yellowish; the median segment with a furrow down its middle; it is narrow at the base, wider and deeper at the apex. Above the middle of the mesopleuræ is a wide and deep, slightly oblique furrow which extends from the base to the apex. The mesosternum has a wide and deep furrow down the middle, which becomes wider and deeper at the apex. Wings smoky, darker at the apex; there is a small, distinct, black cloud at the base and apex of the stigma, the apical one occupying the base of the radial cellule; the stigma in the middle, between the clouds, luteous. The four anterior legs uniformly rufous, the posterior black; the apex of their trochanters and the spurs luteous; the tarsi brownish beneath. Abdomen black; fully three times as long as the head and thorax united; the basal segments rough, the apical smooth in texture; the basal furrowed in the middle at the base; the sides depressed, wider at the base where they form a stout keel, which becomes gradually wider; at its base it is rufous; the raised basal part of the third segment is broader and shorter, dark rufous; the lateral depression at the base is transversely striated; the base of the third segment is flat, strongly irregularly striated; the lateral depression on the fifth segment is short, only reaching to the middle of the segment; the sheaths of the ovipositor thickly covered

with black hair; the epipygium cultriform; the ventral surface dirty yellow.

B. *Abdomen not greatly lengthened, at the most not much more than twice the length of the head and thorax united, the securiform articulation distinct.*

1. *Abdomen not striolated.*

a. Fore-wings with two black clouds.

B. orientalis and *V-macula.*

b. Fore-wings with one black cloud.

B. simlaensis, *lepcha* and *phædo.*

BRACON V-MACULA, *sp. nov.*

Luteus; antennis nigris; capite flavo, supra nigro-maculato; alis flavo-hyalinis, nigro-bifasciatis, apice fuscis. ♀.

Long. 14-15; terebra 10 mm.

Antennæ as long as the body; the scape shining, bearing a few longish, black hairs; the flagellum brownish beneath. Head yellow; the vertex broadly black; the black continued broadly, triangularly behind and as a square in front, to the base of the antennæ; shining, impunctate; the vertex and front covered sparsely, the face more thickly, with longer, white pubescence; the face is sparsely and indistinctly punctured; the mandibular teeth black; the palpi pale testaceous, thickly covered with white hair. Thorax shining, impunctate, sparsely covered with longish, paler hair; the lobes of the meso-notum infuscated, of a mahogany colour; the furrow on the mesopleuræ is curved and extends from the base to the apex. The upper half of the metapleuræ at the apex is deeply excavated; the sides of the excavation oblique; at the base, continuous with it, is a smaller hollow. Legs ferruginous, the tibiæ and tarsi paler, of a faint yellowish

tinge; on the under side of the hinder coxæ is a large **V**-shaped black mark; and beyond the middle of the hinder femora is a broad black line. Wings yellowish hyaline, a broad, oblique, smoky band is on the apex, at and touching the base of the stigma and reaching to the bottom of the discoidal cellule; at the apex of the stigma is a shorter mark of similar colour, which reaches to the cubital nervure, but not touching the basal corner of the radial cellule; in the lower part of the podiscoidal cellule is a fainter elongated cloud, narrowed at base and apex. Abdomen slightly darker towards the apex (perhaps through discoloration); the base of the second segment above forms in the middle a large, somewhat pyriform, raised area; the narrowed end is at the apex, and has, on either side, a deep, elongate depression, the two depressions being separated by a sharp keel; the third, fourth and fifth segments have the lateral and oblique apical transverse depressions distinct; in the middle of the third segments the keel is formed at the base into a clearly defined, triangular, raised space. The ventral surface at the base is obscure lemon-yellow.

BRACON ORIENTALIS, *sp. nov.*

Long. 13; terebra 15 mm.

Similar in the colour of the body and wings to *B. V-macula*, but may be known from it at once by the form of the area on the second abdominal segment; in *V-macula* it is elongate, fully twice as long as the greatest width, and with the apex conical; in the present species it is hardly longer than it is broad, with the apex distinctly triangular; the depression at the base is broader and without a keel.

Antennæ black, distinctly longer than the body; the scape on the lower side thickly covered with longish,

black hair; the flagellum bare, but not smooth. Head yellow, impunctate; the face thickly covered with long, pale hair; the front and vertex smooth, almost glabrous. The front in the middle and vertex broadly black; the black on the vertex continued half way down the back, becoming narrowed towards the apex. Tips of the mandibles black. Thorax shining, impunctate, thickly covered with long, soft hair, which is darker on the mesonotum. The middle lobe of the mesonotum is raised; the middle at the apex is quite flat; the scutellum raised; at the base transverse and bordered by a straight furrow. The apex of the propleuræ is triangularly raised; the oblique furrow on the base of the mesopleuræ is continuous from the base to the apex, and is moderately deep; the oblique furrow on the metapleuræ is wide and with a narrow, distinct furrow in the middle. Legs coloured like the thorax, the anterior of a paler, more yellowish hue; on the outer side of the hinder coxæ is a broad, somewhat Λ-shaped, oblique, black mark. Wings yellowish hyaline; the apices of both broadly smoky; the stigma yellow, black at the apex; in the base of the radial cellule, opposite the black apex of the stigma, is a large, blackish spot, longer than broad; between the base of the cubital nervure and the base of the stigma a slightly narrower and longer cloud runs to the lower apex of the discoidal cellule; in the bottom of the lower discoidal cellule is a fainter cloud, rounded and narrowed at the top, and occupying the lower part of the cellule. Abdomen at the base above coloured like the thorax; towards the apex it is much darker; the ventral surface lemon-yellow; the depression at the base is very deep; the area at the base of the second segment is a little longer than broad, obliquely narrowed at the apex, which almost forms a triangle; on

the third segment there is no transverse furrow at the base; on the fourth and fifth segments the furrows are distinct, forming a triangular space at the base; the basal transverse depressions on these segments are also distinct.

BRACON SIMLAENSIS, *sp. nov.*

Ferrugineus; flagello antennarum nigro; alis flavo-hyalinis, nigro-unimaculatis. ♀.

Long. 17; terebra 12 mm.

Hab. Simla.

Antennæ as long as the body; the scape ferruginous, marked with black laterally; the under side thickly covered with long, rufous hairs. Head shining, ferruginous; the face yellowish, the apex of the mandibles black. Front and vertex shining, impunctate, the vertex sparsely covered with long, greyish hairs; the ocellar region raised; the front broadly depressed, with a distinct furrow down its centre. Mandibles black, testaceous at the base; the palpi pallid testaceous; face covered with long, pale hairs, rather strongly punctured, but with the punctures not close together; the base of the clypeus has a distinct curved keel. Thorax shining, impunctate; the base of the pronotum fringed with long, pale hairs; below the middle it is depressed, the depressions having two short, longitudinal keels on either side and two in the middle. The middle lobe of the mesonotum is raised; the apex is flat; the transverse furrow at the base of the scutellum is stoutly crenulated. The median segment has a gradually rounded slope, and is thickly covered with long, pale hair. Pleuræ shining and impunctate; the pro- and meso- very sparsely, the meta- thickly, covered with long, pale hair; the oblique furrow on the upper part of the meso- wide, shallow; the metapleural furrow wide and deep; the part of it behind the spiracles being slightly deeper. Legs

coloured like the thorax, except the anterior, which are paler, more yellowish ; the femora are sparsely covered with pale hair ; the tibiæ and tarsi very thickly with long, fulvous hair. Wings large, yellowish ; the apex faintly infuscated ; the nervures and stigma yellow ; the extreme apex of the stigma black ; at the base of the stigma is a deep, black spot, longer than broad and extending to the recurrent nervure of which it is the exact length. Abdomen dark ferruginous, the apical segments for the greater part blackish ; the petiole in the middle is raised behind the triangular depression at the base ; the sides depressed, the apex of the raised part rounded ; the middle keeled ; the second segment is widely depressed laterally ; there is a small triangle at the base from which a narrow keel runs down the middle to the apex. The depression at the base of the third segment is stoutly crenulated throughout and is deep ; the furrow on the fourth segment is smooth and narrowed. The ventral segments are black laterally ; the basal pallid yellow in the middle.

BRACON LEPCHA, *sp. nov.*

Long. 15 mm. ♀.

Very similar to *B. simlaensis*, but lighter in coloration, especially the abdomen, which is much paler and without black ; the median lobe of the petiole is more rounded, the oblique furrow on the mesopleuræ is deeper and more clearly defined, and the face does not project so much. Scape of antennæ rufo-testaceous, a large mark at the base above, and a smaller one at the apex black ; thickly covered with long, pale fulvous hair ; the basal two joints of the flagellum fulvous, the rest broken off. Face dull yellowish ; strongly punctured, the punctures large, but not very deep ; moderately thickly

covered with long, pale fulvous hair; the front and vertex very shining, impunctate, the vertex thinly covered with long, pale fulvous hair; the ocelli bordered laterally with a deep furrow; the front without a distinct furrow. The tips of the mandibles are deep black. Thorax shining, smooth, except the depression at the base of the scutellum, which is strongly crenulated. The mesonotum is slightly covered with short, fuscous hair; its middle lobe is not clearly defined; the depression at the base of the scutellum is strongly crenulated, except at the extreme base, where it is smooth. The pronotum in the middle above is broadly and distinctly raised and separated from the sides; behind it is slightly incurved in the middle, with the sides rounded. Pleuræ thickly covered with long, pale fulvous to golden hair; the furrow on the mesopleuræ is broad, moderately deep, oblique, and with a slight curve; the furrow on the meta-pleuræ is curved, slightly narrower than that on the meso-, and is bent sharply downwards in front of the spiracles. Legs covered like the thorax, except that the tibiæ and tarsi have a more yellowish, paler hue, thickly haired, the hair on the front legs being brighter and more fulvous in colour; the claws are black. Wings very large, yellowish hyaline; the apex smoky in both wings; the apex of the stigma is black; at its base is a broad, deep, black spot, extending obliquely from the costa to the recurrent nervure. Abdomen shining, smooth, except for the securiform furrow; and paler, more yellowish in colour, than the thorax; the petiole smooth and shining; the raised middle narrowed and rounded at the base, from which it becomes gradually wider to the apical third; from there it becomes gradually narrowed and rounded; the lateral depression on the second segment curved in the middle, wide, deep in the middle, shallower at the sides; the central keel is complete; the securiform articu-

lation smooth; the middle crenulated; the keels stout, moderately widely separated; the middle keel distinct; the lateral depression large; the central furrow distinct.

BRACON PHAEDO, *sp. nov.*

Long. fere 12 mm. ♂.

Similar in coloration to *B. lepcha*, but smaller, the colour paler, of a more yellowish hue, especially on the legs; the wings also paler, more hyaline; the stigmal cloud smoky, not deep black; the lobes of the mesonotum distinctly infuscated; differing otherwise in the depression at the base of the petiole being larger, deeper and more distinctly triangular; the depressions on the second and third segments deeper and more clearly defined and separated, that on the base of the fourth is irregularly crenulated, not smooth; &c.

Antennæ longer than the body; the scape testaceous, marked laterally with a large, oblique, black mark; the flagellum black; densely covered with a microscopic pile. Head above smooth, shining; the face, especially laterally, of a paler, more yellowish tint; irregularly and rather roughly punctured; the lower part of the face keeled; the apices of the mandibles black; the palpi covered with longish, fuscous hair; the front is shallowly depressed. Thorax shining, impunctate; the middle lobe of the mesonotum slightly, the lateral distinctly, black. The middle of the pronotum is pallid yellow; its apex depressed; the middle of the propleuræ is also pallid yellow and slightly depressed; along the top of the mesopleuræ is a curved, shallow furrow; in the centre of the mesopleuræ is a wider and deeper one, bent in the middle. Legs yellowish-testaceous, darker at the base; the femora sparsely covered with fuscous, the tibiæ and tarsi thickly with paler, hair. Wings yellowish

hyaline ; the apex faintly smoky ; the nervures and stigma yellow ; before the stigma, and extending to the bottom of the discoidal and of the cubital cellule, is a pale brownish cloud. The base of the petiole yellowish ; deeply triangularly depressed ; the sides finely and closely longitudinally striated ; the sides to the apex are deeply and widely depressed and have three central transverse keels and one apical; the middle sharply and distinctly keeled. The basal three-fourths of the sides of the second segment deeply and widely, the apex more narrowly, depressed ; its centre carinate ; the base of the second segment widely depressed ; in the middle are seven stout keels ; the narrowed sides have a few indistinct keels ; the oblique depression is wide, smooth, and deep ; the fourth and fifth segments are indistinctly keeled in the middle ; the penultimate segment has a curved, black line at the base ; the last is entirely black ; the ventral surface, except at the base, yellowish ; the base black ; in the middle of the penultimate segment is a small, smooth space, rounded at the base, transverse at the apex.

C. *Abdominal segments 2 or 3 distinctly longitudinally striolated.*

1. Thorax flat, the lobes of the mesonotum not raised, scutellum foveate; wings fuscous, yellow at the base.
   B. himalayensis.
2. Thorax not flat ; the lobes of the mesonotum distinctly raised ; scutellum not foveate.
   a. Wings fuscous, the base yellow ; abdomen luteous.
   B. indiscretus.
   b. Wings fuscous ; the abdomen black ; thorax rufous.
   B. khasianus and *umbratilus.*
   c. Wings yellow, marked with fuscous at the stigma and apex.
   B. seditiosus, dodonaeus, jejunus, declaratus.

BRACON HIMALAYENSIS, *sp. nov.*

Luteus, abdomine flavo; antennis nigris; alis nigro-fuscis, basi flavis. ♀.

Long. 11 mm.

Scape of antennæ thickly covered above with short, below more sparsely with longer, black hair; the flagellum thickly covered with short, black hair; the scape at the apex on the under side is hollowed and with a leaf-like expansion, roundly incised on the top; the second joint on the under side has the basal half roundly and rather deeply incised. Head shining, luteous; the face of a more pallid yellow colour; the apex of the mandibles black; the palpi pale yellow. Front and vertex shining, impunctate, glabrous, except for a few scattered black hairs; the ocellar region black, and surrounded by a narrow furrow; from it a distinct deep furrow runs to the antennæ; the space over each antenna is depressed. Thorax uniformly luteous, shining, impunctate, except the metapleuræ, which are obscurely punctured and covered with long, white hair; the base of the mesonotum gradually rounded; the rest of it, including the scutellum, flat; on the scutellum at the apex in the middle is an oval, flat depression and, on the sides, is a similar depression, but narrower. The median segment is flat, elongate, smooth above, except for a few stout longitudinal striations in the middle at the apex. The propleuræ deeply furrowed at the top and bottom throughout, the middle raised, carinate. Legs thickly covered with long, pale hair; pale on the femora and tibiæ, more fulvous coloured on the hinder tibiæ and tarsi; the apex of the tarsi black. Wings flavo-hyaline to the transverse basal nervure, including the nervures; the rest of them deep fuliginous; the hind wings are yellow for the same distance as the anterior; the base of the stigma is broadly luteous; the

top of the first cubital cellule is hyaline, and, from this hyaline part, a broad hyaline cloud runs obliquely to the apex of the cellule on the lower side; it being also continued for a short distance into the discoidal. The petiole, in the centre, is raised, the raised part distinctly narrowed at the base, this narrowed part being slightly longer than broad and clearly defined from the rest, which becomes gradually, but not very much, wider towards the apex; is of a bright golden colour and longitudinally striolated; the other segments above are longitudinally striated; the segments bear on either side distinct, striated, oblique furrows; in the middle of the second at the base is a stout, distinctly margined keel, which extends to shortly beyond the middle of the segment, becoming gradually narrowed to a sharp point as it does so.

BRACON INDISCRETUS, *sp. nov.*

Luteus; antennis, vertice, basi mesonoti apiceque abdominis nigris; alis fuscis, basi flavis; stigmate luteo. ♀.

Long. 13; terebra 10 mm.

Antennæ longer than the body, black, thickly covered with a white down; distinctly tapering towards the apex. Head pale yellow; the front and vertex broadly in the middle, and the upper half of the occiput, black. The front and vertex smooth and shining; the vertex covered with fuscous hair; the front broadly furrowed down the middle; the face thickly covered with long, fuscous hair; its upper part in the middle furrowed; its lower with a black mark. The tips of the mandibles black; the palpi luteous. Thorax yellow, above with a rufous tinge; the prothorax in the middle behind, and the basal two-thirds of the three lobes of the mesonotum, black. Thorax smooth and shining; the mesonotum, the median segment, and the metapleuræ sparsely covered with long, soft, pale hair;

the central lobe of the mesonotum is shallowly depressed in the middle; at its apex is a large, deep fovea, conical at its apex, transverse at the base. The oblique furrow on the base of the mesopleuræ is wide; that on the mesosternum wide and shallow. Legs thickly covered with short, fulvous hair; the hinder tarsi with the apical joints fuscous; the wings are yellowish to the transverse basal nervure, except for two fuscous spots on the lower part at the apex; the rest dark smoky, except for a small hyaline cloud below the first transverse cubital nervure; the basal half of the stigma is luteous. The base of the petiole is deeply depressed; the rest of it roundly raised. The basal area of the second segment smooth, flat; the sides of the basal part rounded; the apex triangular; on the apex of the segment is a deep, triangular depression with two thin keels in the middle; the third segment is raised in the centre—broad at the base, gradually narrowed towards the apex—and extending to the middle of the segments, which is depressed on either side of it; the base of the third segment is triangularly raised in the middle at the base, the raised part furrowed down the middle; the fourth segment has two oblique furrows at the base; its apex has a transverse furrow, and is broadly black from the apex to the basal furrows, except down the middle; the apical three dorsal segments are entirely black.

BRACON KHASIANUS, *sp. nov.*

Niger; capite, pedibus anterioribus, femoribus tibiisque intermediis, prothorace, mesonoto scutelloque fulvo-testaceis; mesonoto nigro-3-maculato; alis flavo-hyalinis, apice fere fumatis; stigmate fulvo. ♀.

Long. 12; terebra 18 mm.

Antennæ entirely black; the scape with a few longish,

black hairs; the flagellum closely covered with a short, stiff, microscopic pile. Head pale fulvous; the ocellar region black; the front and vertex shining, impunctate, the vertex (especially behind) sparsely covered with longish, blackish hair; the hinder ocelli bounded on the outer side by a deep, wide, curved furrow; the front one by a much narrower one. Face obscurely punctured, sparsely covered with long, pale hairs. Apex of mandibles black; the middle rufous, the base pale testaceous; the palpi fulvous. The frontal furrow is wide and deep. Thorax smooth and shining; the prothorax, the meso-pleuræ in front of the oblique keel, the mesonotum, except for three large, black marks, the lateral reaching to the apex, but not to the base, and the scutellum, fulvo-testaceous. Scutellum smooth, except for a continuous row of large, deep punctures, which extend almost to the edges. Post-scutellum black. The median segment has a gradually rounded slope, and is shining, impunctate and sparsely covered with longish, fuscous hairs. Propleuræ entirely fulvous, and bearing a rather deep, curved furrow in the middle; the mesopleuræ black, except in front of the oblique furrow and for a roundish projection below it at the base; the metapleuræ entirely black, and broadly and deeply excavated from the basal third; there being also another depression over the middle coxæ. Legs thickly covered with pale hair, that on the hinder legs darker and thicker; the two anterior legs are entirely fulvous; as are also the middle femora, except at the base, and the middle tibiæ. Wings flavo-hyaline, the apex faintly smoky; the nervures, except at the apex, and the stigma fulvous; in front of the stigma the costa is black, and behind this black part is a blackish cloud which extends to the cubital nervure, the apex of the cloud being roundly incised at the bottom. Abdomen deep black; the ventral surface pale

lemon-yellow; the base of the petiole broadly and deeply depressed; the middle of the apical part broadly raised; the base irregularly reticulated with two longitudinal keels in the middle; the apical part has a central and lateral keels, which enclose two wide and deep central, and one narrower and less deep lateral, depressions. The second segment is irregularly, strongly and sharply striated; the central keel extends to the apex, its base very smooth and triangular; on either side of this is a stronger keel, which does not quite reach to the apex, which, at the sides, is much more closely and finely punctured. The depression at the base of the third segment is stoutly striated; the middle of the segment to near the apex strongly longitudinally striolated; the oblique furrows marked with rather widely separated, and not very distinct keels; on the side of the triangular basal space enclosed by them is an indistinct longitudinal furrow.

BRACON UMBRATILUS, *sp. nov.*

Niger; prothorace, mesonotoque cum scutello rufis; alis fuliginosis, stigmate fusco. ♀.

Long. 8; terebra 5 mm.

Antennæ and head entirely black; the front and vertex smooth and shining; the frontal furrow wide and deep; the face and oral region closely and uniformly punctured, and thickly covered with long, white hair; the palpi black, thickly covered with white hair. Prothorax red; black at the base; the propleuræ closely punctured; the base finely striated. Mesonotum smooth, thickly covered with short, white hair; the scutellum finely punctured. The postscutellum and median segment black, the latter minutely punctured, at the apex thickly covered with long, white hair. The base of the mesopleuræ rufous to near the bottom; the oblique furrow is wide and deep. Mesoster-

num closely and minutely punctured; furrowed down the middle. Petiole rugosely punctured; the sides widely depressed, with a few transverse furrows near the apex. The second to the fifth segments are closely rugose; the triangular base of the central keel is longitudinally rugose; the space on either side of it strongly, irregularly reticulated; the sides at the base are depressed, the central portion being sharply raised at the sides. The middle ventral segments are pallid yellow; the hypopygium sharply cultriform. Legs stout, thickly covered with white hair; the tarsal spines fulvous.

BRACON DODONAEUS, *sp. nov.*

Luteus; flagello antennarum terebraque nigris; abdominis medio striolato; alis flavo-hyalinis; macula substigmatali fusca. ♀.

Long. 15; terebra 7 mm.

Scape of antennæ luteous; the sides and beneath black; the flagellum entirely black; indistinctly covered with a microscopic down. Head shining; the face thickly covered with long, fulvous hair; the front with shorter and darker hair; the vertex with the hair longer and paler. Ocellar region indistinctly raised; a straight, not very distinct, furrow at their side; immediately above the antennæ there is a transverse, shallow depression with a flat keel down its middle, the keel becoming wider towards the apex. Mandibles broadly black at the apex. Thorax shining, the base of the median segment obscurely punctured; the pro- and meso-notum almost glabrous; the median segment rather thickly covered with long, fuscous hair; the pleuræ almost glabrous above, the lower part sparsely covered with short, white hair, the middle lobe of the mesonotum is indistinctly raised, not very clearly defined; the scutellum at the apex distinctly

separated from the postscutellum; the latter still more distinctly and widely separated from the median segment, which has a gradually rounded slope. Legs uniformly coloured, the tibiæ and tarsi thickly covered with pale, fulvous hair. Wings distinctly yellowish, the yellow becoming paler beyond the stigma; the apex infuscated, but not deeply; the nervures and stigma luteous; the costa in front of the stigma fuscous, and from this a dark fuscous cloud runs along both sides of the cubital nervure to the end of the first cubital cellule; the cloud on the inner side being broader and, at the middle, less distinct, and interrupted. The sides of the petiole oblique, smooth; on the inner side, next to the central raised part, crenulated; the transverse keels becoming more widely separated towards the apex; the base of the raised part smooth, the middle strongly longitudinally striolated; the central keel being more prominent than the others. The second segment is strongly longitudinally striolated; near the edge is a not very clearly defined, longitudinal furrow. The securiform articulation is longitudinally striated; the striæ smaller and closer together in the centre; the part behind it is longitudinally striated at the base, but not very stoutly; the lateral depression at the base stoutly obliquely striolated; the apex is closely and finely longitudinally striated; on the outer side of the depression the striations are fewer; the depression between the third and fourth segments is closely striolated; the three basal ventral segments entirely, and the fourth and fifth in the centre are pale lemon-yellow. Above, the fourth and fifth segments are blackish.

BRACON SEDITIOSUS, *sp. nov.*

Long. 12; terebra 12 mm.

Agrees in coloration with *B. simlaensis*, except that

the cloud in front of the stigma extends to the edge of the wings on the other side; easily known from it otherwise by the basal part of the second segment being strongly longitudinally striated; and from *B. dodonaeus* by its smooth, not striated, petiole and much longer ovipositor; and *B. lepcha* may be known from it by its perfectly smooth abdomen.

Antennæ black, slightly longer than the body; tapering towards the apex, covered with a pale, microscopic pile. Head rufo-luteous; the vertex covered with long, fuscous hair; the front smooth, shining, and bare; furrowed down the middle, the furrow wide at the base, narrowed towards the apex. The tips of the mandibles black; the palpi pale yellow, covered with long, white hair; the face obscurely punctured, thickly covered with long, fuscous hair. Thorax smooth, shining, thickly covered above with long, fuscous hair; the basal area of the mesonotum raised at the base; the oblique furrow on the mesopleuræ wide and shallow. Legs coloured like the thorax; the femora sparsely covered with long, pale, the tibiæ and tarsi with fulvous, hair. Wings yellowish-hyaline; the apex with a smoky cloud; at the base of the stigma is an oblique, deep black cloud, which extends from the costa to the recurrent nervure, it having near the apex a round, paler space; and it is continued to the apex of the wing as a narrow cloud, originating from its base. The hinder wings have also a smoky cloud at the apex. The petiole is rough; down its middle is a sharp keel, and at its sides a few smaller irregular striations, which form irregular elongated reticulations. The lateral depressions on the second segment large, somewhat triangular and deep; the segment is stoutly striated, except at the apex, where it is smooth; at the base are three smooth spaces; the central is the largest, and is narrowed at the top; the

securiform depression striated, curved at the sides; the other furrows smooth; the hypopygium cultriform; the apex sharp, elongate.

BRACON JEJUNUS, *sp. nov.*

Long. 12; terebra 5 mm.

Comes near to *B. seditiosus*, but may be known from it by its much shorter ovipositor; by the much more roughly striated second abdominal segment; by the third segment being punctured; by the centre of the petiole being much more strongly punctured and the lateral depressions deeper.

Antennæ black. Head luteous; the vertex obscurely punctured; the front smooth; its furrows not much widened at the base; the face rugose; the tips of the mandibles black; the palpi covered with white hair. Thorax smooth and shining. The raised central part of the petiole strongly irregularly longitudinally striolated; the lateral depressions smooth; at their base, before the basal central depression, are four oblique keels. The second segment is coarsely longitudinally striated; the triangular basal area is covered with large, irregular foveæ; the sides at the base are depressed, the depression with curved keels; the securiform depression is wide, deep and striolated; the other depressions are also deep and less strongly striated; the apical depressions are narrow, distinct and obscurely striated. The femora are sparsely covered with pale, longish, the tibiæ, and tarsi thickly with shorter, fulvous hair; the apices of the tarsi black. The apical third of the stigma is black; at its base is a black cloud which extends slightly beyond the cubital nervure; on the lower side of the first cubital cellule is a faint hyaline cloud, which extends into the discoidal cellule.

Bracon declaratus, *sp. nov.*

Long. 10; terebra 3 mm.

Comes near to *B. jejunus*, but is smaller, has the ovipositor shorter, the metapleuræ, the hinder coxæ, trochanters, and femora, fuscous; the middle of the petiole smooth, not striated; the depression on the base of the second segment deeper, especially at the apex; the second cubital cellule longer compared with the third, and the cloud is larger, and not narrowed at the cubital nervure, only narrowed beyond it, near the margin of the wing.

Antennæ deep black, the scape sparsely covered with long, black hair. Head smooth and shining; the face thickly covered with long, white, the vertex more sparsely with fuscous, hair; the face is coarsely punctured; the clypeus is raised, its sides rounded, narrowed towards the top, which is depressed in the middle; the mandibular teeth are black; the palpi pallid yellow. Thorax very smooth and shining, the pleuræ covered with long, white hair. Legs rufo-testaceous; the hinder coxæ, trochanters, and femora blackish, as are also the tips of the tarsi; the tibiæ and tarsi are thickly covered with fulvous hair. Wings yellowish-hyaline, the apex infuscated; the cloud behind the stigma extends slightly beyond the recurrent nervure, and is continued along the median discoidal nervure to the end of the wing; the second cubital cellule is shorter than the third. Petiole, including the raised centre, smooth and impunctate; the second segment strongly irregularly striolated; the lateral depression wide and shallow, deepest at the apex; the basal area strongly and deeply punctured, the central keels raised, except at the apex of the segment. The securiform articulation wide and deep, stoutly longitudinally striolated, more closely and finely at the sides; the apical segments are smooth and shining, without any punctures.

CHAOILTA, *gen. nov.*

Head large, nearly as long as broad; largely developed behind the eyes; the front not depressed; immediately beneath and between the antennæ is a large obliquely projecting, somewhat semicircular, plate with raised margins; between the antennæ, and extending half way into the middle of the projection, where it is obliquely narrowed, is a large flattened plate. Prothorax above bilobate, the basal lobe the larger, and roundly and deeply incised in the middle. Petiole broad; the sides depressed; the second segment is triangularly keeled down the middle at the base; on the sides of the second and third segments at the base are oblique depressions; the securiform articulation is very deep in the middle, where it is longitudinally striated. The prosternum is widely and deeply furrowed, the furrow triangularly widened at the apex; the mesosternum is more narrowly furrowed. The second cubital cellule is large, as long as the third, and twice the length of the first; the recurrent nervure is received shortly in front of the first transverse cubital; the probrachial nervure is interstitial. The antennæ originate from stout tubercles; the scape stout, dilated before the apex into a tooth; the third joint is slightly larger than the fourth. Mandibles thick, with one blunt tooth at the apex. Eyes small, oval, placed on the top of the head and widely separated from the base of the mandibles. Legs short and thick; the hinder coxæ large, broad; the hinder femora not much more than one half of the length of the tibiæ.

The oblique depressions on the abdomen would refer this species to Foerster's genus *Ipiaulax*. The head is much larger and more cubital than usual. The plate and keel on the front are very noteworthy, although we find a spine there in some neotropical species, *e.g.*, in *Ipiaulax nigriceps* Brullé.

CHAOILTA LAMMELLATA, *sp. nov.*

Capite, thorace pedibusque anterioribus luteis ; antennis, abdomine pedibusque posticis nigris ; alis flavo-hyalinis, apice fumatis. ♀.

Long. 17 ; terebra 23 mm.

Scape of the antennæ rufous, black in the middle above ; the flagellum black ; its base and the scape sparsely covered with long, black hairs. Head smooth and shining, the face sparsely covered with long, fulvous hair. Mandibles yellowish ; deep black at the apices ; their base sparsely covered with long, fulvous hair ; the palpi luteous, covered with long, fuscous hair ; the second joint dilated. Thorax above very smooth, shining, and glabrous ; as are also the pro- and meso-pleuræ ; the metapleuræ thickly covered with long, fuscous hair ; the propleuræ have a wide and shallow oblique depression shortly below the middle ; over the sternun is a narrower and deeper furrow ; before the middle of the mesopleuræ is an oblique furrow, narrower and deeper under the wings, wider and shallower lower down. The prosternum deeply furrowed in the middle, the furrow at the apex becoming widely and roundly dilated and showing a yellow triangular space between ; the furrow on the mesosternum largely triangularly dilated towards the apex. The four front legs are of a paler yellow than the thorax ; the middle coxæ in the centre behind, and the greater part of the basal joint of the intermediate trochanters, black ; the hinder legs are entirely black. Wings : the stigma black at the base and apex ; the nervures luteous ; the second cubital cellule is longer than the third and twice the length of the first. Abdomen deep black ; the edges of the petiole and the ventral surface whitish ; the first to the fourth dorsal segments strongly longitudinally striolated ; the depressed sides of the petiole much more finely and

closely striated; the apical segment smooth. In the centre of the base of the second segment is a raised keel, which becomes gradually narrowed to a sharp point, finely and closely punctured at the base; the rest much more strongly and irregularly; the lateral depression on the second segment, wide, oblique, shallow; on the third it is shallower; on the fourth shorter, curved, not so oblique.

SPINARIA ALBIVENTRIS, *sp. nov.*

Rufo-fulva; metathorace pedibusque posticis nigris; abdomine albo, supra late nigro-maculato; alis fulvo-fumatis. ♀.

Long. 12 mm.

Head small, shining, uniformly rufo-fulvous; smooth, the vertex with a few fuscous hairs; the face above with long fuscous, below with some longer fulvous, hairs; the face projecting in the middle, with an elongated fovea above; the palpi are paler; the base of the mandibles closely punctured; the teeth black. Thorax smooth and shining. In the centre of the pronotum above is a large curved spine, sharply pointed at the apex, which reaches to the top of the occiput; in front of this tooth the pronotum is expanded; the expansion widest near the head; the sides slightly curved, distinctly margined; the point curved inwardly towards the middle; above it is keeled down the middle, depressed on either side of this central keel. The middle lobe of the mesonotum is largely raised and separated from the lateral by wide and deep furrows; at its apex in the centre is a stout Y-shaped keel. The scutellar keels stout; and there is, between, in the middle, a longitudinal one of the same thickness; on the scutellum behind is a central and four lateral stout keels; the post-scutellum raised, smooth, triangular; in front of it are two stout, irregular projections; at the sides of these

are some stout, longitudinal keels. In the middle of the median segment is a stout keel running from the base (where it is rounded) to shortly beyond the middle of the segment, outside this is a similar keel which surrounds its apical two-thirds ; outside this again is another originating at the same place, but proceeding to the end of the segment, where they are joined by a transverse keel ; between the two are a few irregular transverse keels, and, at the apex in the middle, is a longitudinal one ; from the outer side at the base a stout keel runs obliquely to the middle, and having on its inner side near the apex three short, stout keels ; on the side, shortly beyond the middle, is a large, stout tooth ; from its sides run obliquely two keels to the oblique inner keel ; behind, two stout keels run to the apex of the segment ; inside of which are two shorter keels united to the apical transverse terminal keel. The propleuræ largely and acutely margined in front and below, projecting at the base into a large, triangular tooth ; at the base is an oblique keel, and, in the middle, three larger, stouter, curved keels, at the apex above are three short keels ; below these are five larger ones, the central being much longer than the others. The prosternum is bordered above by a stout keel. Mesopleuræ smooth ; below is a wide depression, extending from near the base to the apex, where it gets narrower and deeper ; at its base are some keels ; the apical depression is crenulated. Metapleuræ smooth ; the upper and lower part at the base widely furrowed ; the depression on the top surrounded by a stout keel ; the lower part is more deeply and widely depressed and more stoutly keeled beneath ; at the apex in the middle are four keels which become gradually longer. Legs thickly pilose ; the apical joint of the posterior trochanters rufous. The basal segment of the abdomen black above, broadly white down the sides and

more narrowly at the apex; the second is similarly coloured, but with the white narrower; the third and fourth have the sides white; the apical is entirely white. All the segments are stoutly longitudinally striolated; the third and fourth project at the apex into stout, sharp spines, and, in the middle above, into stouter triangular ones; the apical segment ends in a long, sharp, slightly curved spine; the sheath of the ovipositor is black and slightly curved. Wings fulvo-hyaline; there is an oblique, black cloud at the base of the stigma; the apex of both wings smoky; the stigma, costa and the basal nervures luteous.

Only one species of *Spinaria* has been recorded from the Indian mainland;—*S. spinator* Guérin, from Bengal. It differs from the species here described in the thorax being entirely rufous; the abdomen pale red; and the hinder tarsi only black. In its general coloration our species comes nearest to *S. dimidiata* from Ceram. The genus appears to be characteristic of the Indian and Malay Islands.

AGATHIS.

a. Wings hyaline, smoky at the apex.

AGATHIS KHASIANA, *sp. nov.*

Lutea; antennis tarsisque posticis nigris; alis hyalinis, apice fumatis; macula substigmatili nigra. ♀.

Long. 12 mm.

Antennæ entirely black, except for an obscure rufous mark on the upper side of the scape; the flagellum covered with dense, black, stiff, microscopic pubescence; the scape strongly punctured, covered with long white hair. Head: the occiput and vertex thickly covered with longish, fulvous hair; the face with shorter, pale fuscous

hair; the hair on the clypeus longer and darker; the mandibular teeth black; the palpi thickly covered with long, pale hair; the face shagreened; the front before the ocelli broadly and deeply and semi-circularly depressed. Thorax shining, above covered thickly with short fuscous, the sides with pale fulvous, pubescence; the middle lobe of the mesonotum depressed and triangularly produced behind; the base raised, strongly punctured; its middle distinctly raised and almost impunctate. At the base of the scutellum is a broad, deep depression having a stout keel in the middle at the base; the post-scutellum depressed; its sides stoutly keeled. The base of the median segment is sharply depressed; oblique, stoutly keeled in the middle, this keel, at the top, dilating into a somewhat heart-shaped area, the broad end being at the apex; and from it two stout keels run to the apex of the segment where they converge, but do not unite; the sides outside the spiracles are stoutly keeled; the outer keel being joined at its apex by a curved one of similar size which proceeds from the basal keel on the inner side of the spiracles, these being thus enclosed; at the apex of this, and united to it, is a stout L-shaped keel, from which two stout keels run to the apex of the segment. The pro- and meso-pleuræ are smooth, impunctate; the apex of the propleuræ crenulated on the lower half; the lower part of the mesopleuræ is broadly depressed; the depression having stout semi-oblique keels, which are stouter and more widely separated posteriorly. Legs thickly covered with short, fulvous hair; the four anterior have a lighter, more yellowish tint than the posterior; the apex of the hinder tibiæ, the hinder tarsi, and all the claws, black. Wings yellowish, the apex slightly infuscated; in front of the stigma is a black cloud, longer than broad, and with the sides and apex irregular; the part of the costa from

which it originates being also black; above the middle the recurrent nervure is interrupted by a narrow hyaline cloud, curved at the top and reaching near to the middle of the areolet; below this cloud is a shorter and broader curved one which joins the lower part of the discoidal nervure. Abdomen shining, the base and sides thickly covered with fuscous to fulvous hair. The sheaths of the ovipositor are black, pale at the apex, and pilose.

AGATHIS FORTICARINATA, *sp. nov.*

Long. 8 mm.

Is very similar to *A. khasiana* but is much smaller; the apex of the wing more deeply and widely infuscated; the areolet wider at the top; the mesopleuræ closely and distinctly punctured all over, and with the furrow placed higher up; the basal central area of the median segment not heart-shaped, but longer than broad and sharply triangular at the top.

Scape of the antennæ rufous, with a broad black line on the side, the flagellum black. Head entirely luteous, shining; the face obscurely, the clypeus more distinctly, punctured; closely covered with short, fuscous hair; between the antennæ deeply depressed, the sides of the depression largely and sharply elevated; the front broadly, but not deeply, depressed. Mesonotum strongly and closely punctured, especially the middle lobe, which is depressed in the centre, the middle of the depression being raised. Scutellum closely punctured; its apex carinate; its base with a wide and deep depression; the postscutellum with the sides and middle acutely carinate; the middle keel not reaching to the base. The basal central area of the median segment is longer than broad, its base sharply triangular, its apex transverse; the lateral basal keels wider than long; their base on the inner side curved;

the spiracular area large, irregular; its apical keel oblique; the apex of the segment has, on either side at the top, two short, longitudinal keels; its sides are stoutly keeled. The propleuræ shining, impunctate; the apex obscurely crenulated. The mesopleuræ closely and minutely punctured; the base near the middle with a short, longitudinal furrow from which runs downwards obliquely a broad, indistinctly crenulated one, and, slightly upwards, a narrower, shorter, smooth one to the wide, crenulated, apical furrow. Metapleuræ closely punctured; the base with a wide and deep depression, in the centre of which are three stout longitudinal keels. Wings fulvo-hyaline; the apex, from the base of the stigma, and a mark, slightly longer than broad, at the base of the stigma and reaching near to, but not touching, the cubital nervure, deep, fuliginous black; the two transverse cubital nervures do not touch at the top; the first transverse cubital nervure is oblique, straight; the second curved; beneath the cubital nervure is narrowed at the stigma by the hyaline cloud and, in front of the areolet, it is interrupted by it; the recurrent nervure is also interrupted by a bulla at its junction with the cubital, and below the angle above its middle. Legs fulvous; covered with a pale, microscopic pubescence; the hinder coxæ closely punctured; the apex of the hinder tibiæ, and the hinder tarsi, black. Abdomen shining; the apical segments thickly covered with pale fulvous hair; the sheaths of the ovipositor black.

AGATHIS NIGRITARSIS, *sp. nov.*

Lutea; flagello antennarum, tarsis posticis apiceque tibiarum posticarum nigris; alis flavo-hyalinis, apice maculaque substigmatali fuscis, stigmate flavo. ♂.

Long. 9 mm.

Antennæ longer than the body, black; the scape

rufous. Head shining; the face finely punctured, thickly covered with short, fuscous hair; the front in the centre glabrous and very shining; the two lamellæ between the antennæ are stout and widely separated; the palpi thickly covered with white hair; the mandibular teeth black. Thorax unicolorous; the mesonotum has the middle lobe distinctly raised; and with two wide depressions down the middle and closely punctured; the lateral lobes are closely, but not strongly, punctured. Scutellum closely and coarsely punctured; the transverse keel at its apex stout; the depression behind it is wide and deep and has two longitudinal keels on either side of the middle; in the middle behind is a distinct semicircular keel. The base of the median segment is oblique and has a stout keel down the middle, its apex being bordered by a stout keel; the slope of the segment at the top is bordered by a stout keel; between this and the basal transverse keel are two straight keels having on either side a larger, oblique one; the spiracular area is bounded by two keels forming a triangle, which is united to the keel bounding the top by two small oblique keels. Propleuræ smooth; the mesopleuræ obscurely punctured; the furrow is oblique, wide, deep and traversed by eight stout keels. Metapleuræ closely, but not strongly, punctured. The lower part is bounded by a stout keel; and there is a short, oblique one over the coxæ. Legs uniformly coloured, except the apex of the hinder tibiæ and the tarsi, which are black. Wings yellowish-hyaline; there is a black, squarish mark at the base of the stigma; the apex is smoky; the first transverse cubital nervure is oblique; the second has the upper half oblique, the lower straight. Abdomen smooth and shining.

Comes near to *A. forticarinata*, which may be known from it by the different arrangement of the metanotal

areæ ; in *forticarinata* the basal central one is triangular at the base, the apex transverse ; in the present species it is shorter, broader and rounded at the base, while there is, at its apex, an intermediate area which is absent in *forticarinata*, the latter too having the pleuræ more strongly punctured.

AGATHIS PERONATA, *sp. nov.*

Long. 9-10 mm. ♂.

Resembles closely *A. forticarinata*, from which it differs by the two clouds in the wings being fainter, by the hinder tibiæ being almost entirely black, by the median segment being stoutly transversely striated, and by the central basal area being transverse, not triangular, at the base; by the furrows on the mesopleuræ being wider, deeper, and more strongly crenulated; by the three keels on the metapleural depression being more widely separated, especially in the upper two, which are more widely separated than are the middle and lower, while in *A. forticarinata* the three are separated by almost the same distance.

Antennæ longer than the body, black; the scape rufous beneath, thicky covered with longish, pale hairs; the flagellum thickly with short, stiff, black hair. Face shining, indistinctly punctured; thickly covered with short, black hair ; the clypeus more strongly and distinctly punctured than the face, and clothed like it; the palpi covered with long, pale hair; the vertex and occiput thickly covered with longish, fuscous hair; the front shining, bare, not greatly depressed. Middle lobe of the mesonotum greatly raised above the lateral; strongly punctured, depressed in the middle ; the depression raised in the middle ; the raised part being more closely punctured, and with the punctures smaller than they are on the sides. Scutellum strongly punctured; a stout, curved keel on its apex; the depression at its base

very large and deep, and with a keel in the middle at the apex; the lateral keels large, acute. Postscutellum depressed; its sides carinate; at the apex of the mesonotum is a stout bordering keel which projects into the centre of the postscutellum sharply; and, from the centre of the projection, a stout, straight keel runs down to the base of the median segment, which is obliquely raised and keeled in the middle. The median segment is stoutly transversely striolated, most strongly at the base; the top of the depression is keeled; the central area is longer, by about one-half, than its breadth; its base is angled, but not acutely; the apex is transverse; the lateral areæ are of the same length; they are wider and open at the apex on the inner side; the bounding apical nervure being interrupted on one side in all three areæ; the apex of the segment is rough, irregularly reticulated. Propleuræ smooth; its apex obscurely crenulated; the mesopleuræ punctured all over; the oblique furrow wide and deep, bearing stout, widely-separated keels; the longitudinal furrow wide; the metapleuræ more closely and strongly punctured than the meso-; the basal furrow wider and deeper than that on the apex of the mesopleuræ; the three keels in it stout; the upper separated from the central by a greater distance than that is from the lower; the lower part from the base is irregularly keeled, and from the centre of this keel a stouter, straight one runs to the apex, forming a triangular area. Legs, especially the coxæ and femora, closely punctured; thickly covered with short hair, which is somewhat fulvous in tint on the front legs; the hinder tarsi and the hinder tibiæ, except for a rufous band near the base, black. Wings yellowish hyaline; the apex slightly infuscated; the spot behind the stigma is longer than its breadth and brownish; the lower part of the stigma is pale yellow; the areolet is rounded at the top, the nervures

uniting there; the lower nervure is faint; at the top the recurrent nervure is separated from the cubital by a bulla; there is another bulla shortly above the middle of the nervure; so that, with these two bullæ, a small piece of the nervure is completely separated from the rest. Abdomen shining, impunctate.

AGATHIS MELANOCERUS, *sp. nov.*

Lutea; vertice antennisque nigris; alis flavis, apice fere fumatis. ♀.

Long. 11 mm.

Antennæ entirely black, except for a rufous mark on the base of the scape; which is covered with blackish hair. Head luteous, the upper part in front and behind black. Face impunctate, thickly covered with fuscous hair; below the antennæ is a triangular depression; the mandibular teeth black and piceous. Mesonotum of a brighter, less pallid, yellow hue than the rest of the thorax; its central lobe roundly raised, not depressed in the middle; the depression at the base of the scutellum wide and deep; its middle keel reaching near to the base. The base of the scutellum has a straight, oblique slope and is keeled at the top, is almost impunctate and glabrous, and has at the apex a stout, slightly curved keel. The base of the median segment has a semi-oblique slope, is stoutly keeled round the apex and down the middle; the central area is longer than its breadth, triangular at the base, transverse at the apex, and has a stout, transverse keel shortly beyond the middle; the lateral areæ next to it are slightly wider than it is at the top, but distinctly narrower at the bottom; the keel bounding the spiracular area at the apex is curved, slightly oblique. Pleuræ shining; the meta-obscurely punctured; the oblique furrow on the meso-wide and deep and having stout, widely separated keels;

the furrow on the base of the meta- deeper in the middle, but hardly so wide as that on the meso-, and has in the middle four equidistant keels. Legs stout, coloured like the body, except for the hinder tarsi which are black; thickly covered with white to fulvous hair; the hinder calcaria blackish towards the apex. Wings yellowish, the apex slightly fuscous; the areolet obliquely triangular; the first transverse cubital nervure is oblique; the second is roundly curved. Abdomen very shining, impunctate, the apex darker coloured than the base.

b. Wings entirely fuscous; the transverse cubital nervures not uniting at the top.

AGATHIS NIGRITARSIS, *sp. nov.*

Lutea; antennis, apice tibiarum posticarum tarsisque posticis nigris; alis fuscis. ♂.

Long. fere 8 mm.

Scape of antennæ black, thickly covered with black hair; the flagellum wanting. Head uniformly luteous, the front and vertex shining, obscurely punctured, thickly covered with fuscous hair. Clypeus impunctate, pallid yellow; the tips of mandibles black, the palpi thickly covered with long, pale hair; from the hinder ocelli a stout, not very clearly defined, keel runs obliquely to the eyes; between the antennæ the front rises in two triangular projections. Thorax shining; the pleuræ impunctate; the mesonotum with a few indistinct punctures; its middle lobe not largely elevated; its base oblique; its centre at the base slightly raised; the scutellum slightly raised, impunctate; the depression at its base wide and deep; at its apex is a tranverse keel. The base of the median segment broadly and deeply depressed; in the middle of the depression are two stout keels, slightly curved, uniting

into one oblique keel at the apex; there are four distinct areæ; the central basal one triangular at the base; the apical central is nearly square, with an indistinct keel in its middle; the basal lateral one is twice as broad as its length; the apical nearly square; the apex of the segment is sharply oblique; in its centre is a large area which reaches near to the apex of the segment; it is longer than its width and rounded at its apex. Pro- and meso-pleuræ shining, impunctate; the metapleuræ obscurely punctured; thickly covered with long, white hair; at the base, on the lower side, are two large keels forming nearly a triangle. Legs coloured like the thorax, thickly covered with white hair; the apex of the hinder tibiæ and the hinder tarsi deep black. Wings deep fuliginous, shining; the base of stigma broadly pallid luteous; the base of the first cubital cellule and a curved elongated line reaching from shortly beyond the top of the recurrent nervure to the middle of the second cubital cellule and with an oblique broader branch issuing from it on the outer side of the recurrent nervure, hyaline. The cubital nervure is interrupted by a bulla on either side of the transverse cubital nervure. Abdomen shining; the ventral surface at the base pallid yellow; the apex with a few longish hairs.

AGATHIS FULIGINOSA, *sp. nov.*

Nigra; *alis fuliginosis*, *nervis stigmateque fuscis*. ♀. Long. 8 mm.

Antennæ black; the scape shining, sparsely punctured and sparsely covered with short, black hair; the flagellum opaque, thickly covered with a close, microscopic down. Head shining, impunctate; the face thickly covered with short, black hair; the clypeus sparsely with longer, paler hair; front depressed, very smooth and shining; from the upper side of the front ocellus runs a thick, curved keel,

the two uniting into one above the antennæ and forming a large, somewhat heart-shaped, area; a stouter, broader, blunter keel runs from between the middle of the ocelli obliquely to the eyes; the front broadly projects between the antennæ; and from between them a broad furrow, about three times as long as broad, runs down the face, Thorax black; the pro- and meso-thorax shining, impunctate. The depression at the base of the scutellum is wide and deep; in its centre is a stout longitudinal keel, bordered on either side lower down by a thinner one; the post-scutellum is placed much lower down than the scutellum; is hollow, wider than its length and ends in the middle at the apex in a stout keel. The depression at the base of the median segment is wide and deep; the segment, except at the base, is thickly covered with longish, dark hair; in the middle is one continuous area, narrow at the base, becoming gradually wider to the apex, which is rounded; in it, before the middle, are two transverse, not very stout or distinct, keels; the upper lateral area is a little wider than long, almost square; in its outer side is a depression which extends from top to bottom, becoming gradually narrower as it does so. Propleuræ deeply excavated, especially in the centre beneath, which bears in the middle of the hollow, some stout, transverse keels; the mesopleuræ at the base beneath has a deep depression, wide at the bottom, narrow at the top; where it curves round to near the middle; in the narrow top part are three stout, transverse keels; the upper two of which are nearer to each than the lower pair are to each other; in the curved lower part are two distinct septa, forming two large distinct foveæ; the lower being the larger and deeper. The metapleuræ are broadly raised in the middle, the raised part very rough; irregularly reticulated; its apical part deeply depressed, the depression divided in the middle by

a keel. Legs, especially the tibiæ and tarsi, very thickly covered with stiff, black hairs. Wings uniformly coloured, except for a small hyaline spot at the base of the cubital, and a more elongated one touching the lower part of the discoidal nervure in front; the transverse median nervure is received immediately in front of the basal nervure, almost touching it. Abdomen smooth, shining; the petiole depressed at the base, the middle indistinctly triangularly raised.

MICRODES.

The two species here described agree better with this genus rather than with *Earinus*, with which they agree in some other respects. They agree also with *Disophrys* in the second transverse cubital nervure emitting a short branch, and one of the species (*tuberculatus*) approximates to it by having a horn between the antennæ. Apart from the marked distinction in coloration our two species may be separated as follows:—

A stout tubercle berween the antennæ, the mesopleural suture smooth. *M. tuberculatus.*

No tubercle between the antennæ, the mesopleural furrow bearing oblique keels. *M. fumipennis.*

MICRODES TUBERCULATUS, *sp. nov.*

Ferrugineus, flagello antennarum abdominisque apice nigris; alis flavo-hyalinis, macula substigmatali nigra, apice fumato.

Long. 10; terebra 6 mm.

Antennæ as long as the body, black, the scape rufous. Head shining, impunctate; the face sparsely covered with short, soft, white hair; the palpi are thickly covered with long, white hair; between the antennæ is a stout plate, which becomes gradually smaller behind and is rounded in front. Thorax shining, impunctate, almost glabrous;

the postscutellum is hollowed and bordered by a semicircular keel. The median segment has at the base a transverse keel, from the centre of which runs a longitudinal one to near the middle of the segment; outside this a stout keel runs from near the base to the apex; on the apical half at the sides is a stout longitudinal keel. Pleuræ shining, impunctate; on the lower part of the meso- is a longitudinal furrow. The base of the mesosternum is oblique and is keeled at the sides and below; on the apex in the middle is a large, triangular depression. Legs coloured like the thorax; the front pair paler; the tibiæ and tarsi thickly covered with fulvous hair. The apical cloud in the fore wings extends from the second cubital cellule to the apex; at the base of the stigma and extending on to the costa is a deep black cloud, which is longer than its breadth; the branch on the second transverse cubital nervure issues from above the middle and is twice as long as the transverse cubital nervure, but becomes fainter towards the apex. The basal segment of the abdomen is depressed deeply at the base and apex; the sides sharply keeled; the apical depression, the apex of the petiole and the second and third segments are strongly longitudinally striated; the others are smooth; the apex of the petiole and the basal half of the second segment, the apex of the third in the middle and the apical segments are black, smooth and shining.

MICRODES FUMIPENNIS, *sp. nov.*

Niger; prothorace, mesonoto, mesopleuris supra pedibusque anterioribus rufis; alis fumatis, stigmate nigro. ♀.

Long. 8 mm.

Antennæ as long as the body; black, thickly covered with short, black hair. Head black; the part between the lower part of the eyes and the base of the mandibles

white ; the mandibles obscure testaceous ; the palpi black ; the face shining, covered with short, black hair ; the labrum obscure testaceous ; the front and vertex shining, impunctate ; the front somewhat triangularly raised below the ocelli ; the raised part being depressed in the middle. The prothorax uniformly rufous ; below thickly covered with long, white hair ; its top in the centre is raised ; below it is a stout, oblique keel. Mesonotum shining, the sides obscurely shagreened ; the middle lobe clearly separated ; the scutellum thickly covered with short, white hair. Median segment black, thickly covered with white hair ; the central area is narrowed at the base and apex ; there is a stout, transverse keel near the base, and another shortly beyond the middle. The upper part of the mesopleuræ largely rufous ; the black lower part is depressed obliquely, the top bearing a row of striations. The metapleuræ entirely black ; the oblique furrow at the base is wide and deep ; the lower half is coarsely reticulated. The wings are uniformly coloured, except for some hyaline clouds at the base of the stigma in the cubital and discoidal cellules. There are two distinct bullæ in the recurrent nervure near the top, the part between them being elbowed ; the second transverse cubital nervure is bullated below the middle ; the branch emitted by it is as long as the nervure itself. Abdomen deep black ; the basal ventral segments pale testaceous ; the petiole is longer than the second segment ; its basal two-thirds are bordered laterally by two sharp keels, which approach each other near the base, becoming wider apart towards the apex, the space between being hollowed ; its apex has two stout central, and two or three shorter and more irregular longitudinal keels. The second and third segments are stoutly longitudinally striolated, the latter to near the apex, which is strongly

aciculated, and bear a transverse furrow in the striated part. The other segments are obscurely aciculated and sparsely covered with long, black hair.

DISOPHRYS RUFICOLLIS, *sp. nov.*

Niger; capite, prothorace, mesonoto pedibusque anterioribus ferrugineis; alis flavo-hyalinis, apice maculaque stigmatali fuscis; nervis stigmateque flavis.

Long. to end of petiole, 7 mm.

Head rufous; the middle of the front and vertex broadly, and the upper part of the occiput black, smooth, shining, the face and clypeus thickly covered with long, fuscous to fulvous hair. Thorax shining, smooth; the prothorax, the mesonotum with the scutellum and the upper part of the mesopleuræ rufous. The depression at the base of the scutellum is large and deep, and has two keels in the middle; on the top of the scutellum, near the apex, is a transverse keel; the postscutellum is depressed, black, and surrounded by a black keel, and from it runs a lighter coloured, curved one. The base of the median segment is depressed and has in the middle a stout, rounded keel, from which two stout keels run to the apex; the base of the area enclosed by them is triangular and is separated by a transverse keel; the apical depression on the metapleuræ has seven stout keels; the oblique furrow on the apex below the middle has some obscure keels at the base. The mesosternum is widely depressed in the middle at the apex and is furrowed down the middle. The tibiæ and tarsi are thickly covered with fulvous hair. The black mark at the base of the stigma extends into the middle of the discoidal cellule; there is only a short stump on the second transverse cubital nervure.

This species agrees with *Disophrys* in having two

distinct lamellæ between the antennæ. The branch issuing from the second transverse cubital nervure is short; the abdominal segments are smooth without any striations as in *Microdes*; the furrow on the mesopleuræ is wide and deep, and obscurely marked with keels. My only example wants the apex of the abdomen.

ICHNEUMONIDAE.

OPHIONIDES.

OPHION.

This genus is divided into two sections, according to the neuration of the anterior wings.

A. *The basal abscissa of the cubitus not thickened; the cubital nervure with an abbreviated projection opposite the base of the stigma* = OPHION, *sensu Lat.*

The two species here described may be separated as follows:

(*a*) The recurrent nervure received opposite the end of the basal abscissa of the radius; the depression at the base of the median segment indistinct, triangular; the middle lobe of the mesonotum fuscous; the basal transverse keel on the median segment indistinct.

O. fuscomaculatus.

(*b*) The recurrent nervure received distinctly in front of the end of the basal abscissa of the radius; the depression at the base of the median segment large, deep, semicircular; the basal transverse keel distinct; the orbits and vertex broadly yellow. *O. areolatus.*

OPHION FUSCOMACULATUS, *sp. nov.*

Long. 15 mm.

This species agrees with *O. univittatus* Lep. in having

the mesonotum marked with "une bande brune"; but the "metathorax is covered with fine curved striæ, without any other indication of the absence of the first division than the absence of the striæ above"; here there are no transverse striæ; there is a distinct transverse keel across the middle, from which two finer keels run down to the apex, enclosing a finely longitudinally striated space.

Face and clypeus ferruginous, inclining to yellow at the eyes; the outer orbits and occiput entirely pale yellow; the vertex darker; the mandibular teeth black; the face and clypeus roundly projecting in the middle and not separated. Antennæ ferruginous, darker towards the apex. Thorax pale fulvous-yellow; the mesonotum of a darker hue; its middle lobe for the greater part dark fuscous, not clearly defined from the lateral. Scutellum shining, smooth, pallid yellow; the sides not keeled above; post-scutellum distinctly raised; its apex with an oblique slope; from its base a fine keel runs to the wings; below the keel there is a small striated band. The depression in the middle at the base is broader than its length, narrowed to a point in the middle at the apex and longitudinally striated in the middle; across the middle of the median segment is a stout, transverse keel behind which, in the centre, is a shallow depression; the apex of the segment oblique, the middle finely longitudinally striated. Pleuræ smooth and shining. Legs coloured like the thorax. Wings hyaline, the stigma rufo-fulvous; the nervures black; the apex of the cubital cellule is sharply triangular; the triangular part of equal length above and beneath through the recurrent nervure being received opposite the apex of the basal abscissa of the cubitus; the transverse median nervure is received immediately in front of the transverse basal. Abdomen ferruginous: the base of the petiole paler.

OPHION AREOLATUS, *sp. nov.*

Long. 15 mm.

The orbits broadly and the vertex pale lemon-yellow; the face and occiput ferruginous, suffused with yellow. The face and clypeus finely, but distinctly, punctured; the clypeus separated by a furrow from the face, and with a deep oblique furrow at the sides. Mandibles smooth, and yellow at the base; the middle punctured; the teeth black. Thorax with the sides and scutellum of a distinct yellow hue; the furrows bordering the middle lobe of the mesonotum at the base wide, deep, distinct. Scutellum smooth; the sides not carinate; the postscutellum distinctly carinate at the base; its apex with an oblique slope; its sides oblique, becoming wider towards the apex. The depression at the base of the median segment wide, deep, semicircular; in front of this is a transverse keel, from which run two stouter keels to the apex; from the middle of these runs a stout, curved keel to the middle of the base of the petiole; there being inside this an oblique keel; the whole forming, on the apex of the segment, a central and two lateral areæ. Pleuræ shining, impunctate; the depression below the tubercles wide and deep; from its apex runs, obliquely to the hinder coxæ, a distinct furrow, widest and deepest at the apical half. Wings clear hyaline; the stigma rufo-fulvous; the nervures black; the transverse median nervure is received on the inner side of the transverse basal; the second recurrent nervure is received distinctly in front of the apex of the basal abscissa of the radius; the apex of the cubital cellule being thus longer on the lower than on the upper side.

A distinct species. Easily known, *inter alia*, from *O. fuscomaculatus*, by the areolated apex of the median segment.

B. *The basal abscissa of the cubitus thickened, the cubital cellules with horny points = Enicospilus.*

ENICOSPILUS RETICULATUS, *sp. nov.*

Fulvus; antennis flavis; mesonoto abdomineque late nigris; alis hyalinis, nervis stigmateque nigris. ♀.

Long. 30 mm.

Antennæ longer than the body, uniformly coloured; the scape obscurely punctured; sparsely covered with pale hair; the flagellum thickly with a fuscous, microscopic pile. Head fulvous; the face with a faint yellowish tinge; the ocellar region deep black; the face distinctly punctured; the clypeus obscurely punctured; the apex smooth. Mandibles closely punctured at the base; the teeth deep black; the palpi fulvous, covered thickly with long, white hair. Thorax fulvous; on the mesonotum are three large black marks, and on the mesosternum two large black marks. The depression at the base of the scutellum large and deep; the keel bordering it covered with long, pale hair; the base of the scutellum is closely and finely punctured, closely longitudinally striated, and the whole thickly covered with long, white hair; at the apex there is a small part separated from the rest by a keel, and of a darker colour and closely longitudinally striated; the postscutellum indistinct, and bordered on either side by a stout, oblique keel. The base of the median segment is obliquely depressed at the base and apex; the centre at the base has a long central, bordered by a shorter keel and the edges by a curved one; the apical part smooth and without any keels. The smooth basal part of the median segment is bordered by a curved keel; in front of this the segment is stoutly irregularly reticulated; in the middle at the base are two straight narrow keels; the centre beyond these bordered by a much stouter keel; the

central bordered area has, at the top, two or three stout transverse keels; the apex is smooth. Pro- and meso-pleuræ smooth; the apical furrow on the mesopleuræ crenulated; the apex on the lower side obscurely obliquely striated. Down the middle of the metapleuræ is a curved keel, the lower edge bordered by a much stouter and sharper one; the space between them bearing some stout, slightly oblique keels; the apical part above this has similar keels but stouter and more distinct. Legs uniformly coloured and thicky pilose. Wings hyaline; the bare space on the base of the cubital cellule with one large horny point, which is sharply dilated on the lower side at the base and apex; the third segment of the abdomen is black, except on the lower third; the three apical segments are entirely black; the fourth segment is of a paler colour than the basal.

ENICOSPILUS STRIATUS, *sp. nov.*

Flavus; alis hyalinis, stigmate fulvo; metanoto striato. Long. 16 mm.

This species may be known from *E. reticulatus* by being smaller, by the thorax and abdomen being devoid of black, by the scutellum not being distinctly narrowed towards the apex, not longitudinally striated, and more distinctly keeled laterally and by the transverse median nervure not being united to the transverse basal, but received distinctly behind it. The Ceylonese *E. ceylonicus* Cam. comes near to it, but may be known by the median segment being only coarsely shagreened, not striated, and by there being four horny spots in the fore wings, instead of one only as in the present species.

Face closely punctured, the depression below the antennæ in the middle ending in a shining, blackish tubercle; the tips of the mandibles broadly black. Meso-

notum slightly infuscated, closely punctured and covered with a short, white down. Scutellum distinctly and gradually narrowed towards the apex; its sides carinate; its base closely punctured; the apex rough, obscurely punctured and transversely striated; at the apex below there is a stout, curved keel, from the end of which on either side, a curved keel runs to a transverse one. The base of the segment deeply and widely depressed, the depression stoutly longitudinally keeled in the middle; the apex in the middle broadly deeply triangularly depressed. This basal part is bordered by a stout transverse keel; in front of this the segment is irregularly longitudinally striated; the apical half stoutly striated, the striæ curved, almost semicircular. Propleuræ closely obliquely striated; the mesopleuræ closely punctured; the lower corner at the apex with a wide depression; at the base on the lower half is a curved keel. Wings hyaline, the stigma fulvous, the nervures dark fuscous; the single horny point oblique, longer than its breadth, the apex bluntly rounded; the base sharply narrowed; the transverse median nervure is received distinctly in front of the transverse basal. Legs lighter in colour than the body, the tibiæ and tarsi having a distinct yellowish tint.

SCHIZOLOMA FULVICORNE, *sp. nov.*

Nigrum; antennis fulvis; abdomine rufo; pedibus anterioribus flavis; alis fulvo-hyalinis. ♀.

Long. 33 mm.

Antennæ fulvous, more yellowish in tint towards the apex; the scape lemon-yellow, densely covered with long, pale hair. Head black; the face and clypeus, a line on the inner orbits, broad at bottom narrower at the apex and almost interrupted above the middle, and a

short line above the middle of the outer orbits, yellow. The head behind the eyes is strongly punctured; the punctures all clearly punctured; the vertex is more strongly punctured. The clypeus is of a paler yellow than the face, is black at the base, and is strongly punctured, especially at the sides; the mandibles yellow, black at the apex. Thorax black; densely covered with dark fulvous pubesence; the pro- and meso-thorax closely and strongly punctured; the propleuræ in the middle behind longitudinally striolated; the mesopleuræ at the base above with curved striations, below with the striations oblique, between these irregularly reticulated; the depression at the apex is crenulated. Scutellum thickly covered with long, fuscous hair; the base is, if anything, more strongly punctured than the mesonotum; the sides to the apex longitudinally striolated, running into irregular reticulations; the apex in the middle is rough, irregularly obscurely reticulated. Median segment strongly reticulated; at the base the areæ are longer than broad, in the middle broader than long; in the middle at the apex the keels form a large area rounded and narrowed at the base, and having inside of it three stout, slightly curved keels. The metapleuræ at the base have at the top a wide and rather deep depression, the sides of which are oblique, the middle with some stout, transverse keels; the rest of them strongly and irregularly reticulated. The four anterior legs are yellow, the femora more fulvous in tint; the hinder coxæ are black, the apex reddish; the middle beneath yellow, the hinder trochanters bright, the femora dark rufous; the basal two-thirds of the hinder tibiæ of a still darker rufous; the apex black; the hinder tarsi yellowish fulvous, densely covered with fulvous—dark on the metatarsus, brighter on the apical joints—hair; the second joint flat on the inner side, with the apex dilated.

Wings fulvo-hyaline; the stigma rufo-fulvous; the nervures darker. Abdomen ferruginous, the petiole and second segment black above.

The ♀ is similar in coloration, except that the hinder coxæ wants the yellow and the hinder tarsal joints are not dilated.

PANISCUS.

The species of this world-wide genus are difficult to separate owing to their extreme similarity in colour, structure, and sculpture. The species here described fall into two clearly-defined sections, the species forming the first having especially well marked characters.

A. *The transverse basal nervure completely interstitial; the areolet appendiculate at the top; the keel on the apical third of the median segment reaching near to the middle of the segment, which is not distinctly transversely striated.*

PANISCUS INTERSTITIALIS, *sp. nov.*

Flavo-rufus; capite flavo; mesonoto fusco; alis hyalinis nervis nigris, stigmate flavo.

Long, 10 mm.

Head lemon-yellow; the mandibles and palpi of a more reddish hue; the mandibular teeth black; the face closely, but not strongly, punctured; the face and clypeus covered with short, white hair; the clypeus at the apex covered with long, dark rufous hair; the ocellar region blackish only between the hinder ocelli. Antennæ uniformly rufous; very sparsely pilose. Mesonotum infuscated; the middle lobe blackish; the scutellum dark rufous above; the sides pallid yellow; the post-scutellum roundly oblique at the base and apex; the median segment roundly depressed at the base; the apex is raised in the middle;

its sides slightly depressed and bordered behind by a stout, curved keel. Pleuræ smooth and shining, of a paler, more yellowish, tint than the mesonotum ; the furrow at the base of the metapleuræ is wide and deep ; the keels down the middle, bordering the apex, and the lower side stout, clearly defined throughout. Legs rufous ; the coxæ, trochanters, and hinder tibiæ pale lemon-yellow. Wings clear hyaline ; the costa and stigma yellowish ; the nervures black at the base, lighter, more fuscous, in tint towards the apex ; the areolet oblique, narrow, longish, shortly, but distinctly, appendiculated at the top ; the lower half of the second transverse cubital nervure is largely bullated at the apex ; the recurrent nervure is interstitial with it ; the part of the cubital nervure bordering it on the lower side has a sharp, oblique slope from the base to the apex ; the recurrent nervure is largely bullated at the top and, to a less extent, below the middle, the transverse median nervure is interstitial ; there is no " stump " on the cubital before the areolet. Abdomen slightly infuscated towards the apex.

B. *The transverse basal nervure not interstitial ; the areolet not appendiculate at the top ; the keel on the apical third of the median segment short ; the segment closely and strongly transversely striated.*

Body ferruginous, yellowish only round the eyes ; the median segment closely punctured, only obscurely striated near the apex in the middle ; antennæ fuscous. *P. ferrugineus.*

Body yellowish or testaceous ; the median segment distinctly, transversely striated ; antennæ rufous or testaceous. *P. longitarsis.*

PANISCUS FERRUGINEUS, *sp. nov.*

Ferrugineus, orbitis oculorum flavis ; flagello anten-

narum fusco; alis hyalinis, stigmate flavo, nervis nigris. ♀.

Long. 14 mm.

The scape and base of the flagellum rufous; the rest of the flagellum fuscous, almost black. Head ferruginous; the orbits of the eyes lemon-yellow; the ocellar region deep black. Face strongly and closely punctured; the base of the clypeus less strongly and closely punctured; the apex with the punctures still more widely separated; the apices of the mandibles black; the palpi rufous, sparsely covered with long, white hair. Thorax uniformly ferruginous, except the base and apex of the mesopleuræ which are yellow; and the sides of the scutellum and the postscutellum, which have a yellowish hue. Mesonotum closely, but not strongly, punctured; the parapsidal furrows not very deep. Scutellum closely punctured; the depression at its base deep; the lateral keels large, especially at the base; the sides of the post-scutellum keeled on the basal half; the depression on the base of the median segment longish, extending almost to the sides; slightly curved, narrowed laterally; the rest of the segment closely and rather strongly punctured, obscurely transversely striated in the middle towards the apex, where there is no keel. Pro- and meso-pleuræ closely and strongly punctured; the space on the mesopleuræ above the oblique furrow more shining, and with the punctures much more clearly and widely separated; the furrow on the metapleuræ narrow at the top, wider and deeper at the bottom. Legs ferruginous; the tibiæ and tarsi thickly covered with whitish pubescence; the spines rufous; the claws deep black. Abdomen infuscated towards the apex; the sheaths of the ovipositor black.

PANISCUS LONGITARSIS, *sp. nov.*

Fulvus; facie apiceque metanoti flavis, vertice nigro;

alis hyalinis, stigmate flavo, nervis fuscis; metanoto striolato. ♂.

Long. 22 mm.

Hab. Simla.

Antennæ ferruginous, darker at the apex. Face and clypeus lemon-yellow; the face roundly dilated in the middle; thickly covered with short, fuscous, the clypeus with much longer, blackish, hair; the hair much longer at the apex. Mandibles rufous at the base, covered with long, golden hairs; the teeth black; the palpi long, pallid yellow, sparsely covered with white hair. The ocellar region deep black; the front yellow, reddish in the middle; the semi-circular furrow in front deep; and there is a similar one above each of the antennæ. Thorax ferruginous, the sides more yellowish; the middle lobe of the mesonotum clearly defined; the part between its apex and the base of the scutellum flatly depressed in the middle. Scutellum closely and minutely punctured; the lateral keels stout; the apex depressed and with the bordering keels narrower. Postscutellum widely depressed at the base; its middle raised and sharply margined by a stout carina; the keels bordering the apex depressed. Median segment coarsely transversely striated; the depression at the base extending to the edges of the segment; broad in the centre, much narrower at the sides; the apex is lemon-yellow; the keel distinct; at the sides on the apical third is a short, curved keel. Pro- and meso-pleuræ yellow, suffused with rufous; the meta-pleuræ not quite so yellowish, except at the apex; the central keel is complete, the part below it finely, obliquely striated. Legs coloured like the thorax; the hinder tibiæ and tarsi paler, through being densely covered with short, white hair; the hinder tarsi are longer than usual, compared with the tibiæ. Wings clear hyaline; the stigma

fulvous; the nervures blackish; the areolet oblique, narrow; the lower part of the second transverse cubital nervure obliterated, and from the apex of the thick part a faint nervure runs obliquely to join the recurrent nervure; the top of the areolet is sharply triangular. Abdomen ferruginous, if anything darker towards the apex.

HETEROPELMA RETICULATUM, *sp. nov.*

Nigrum; antennis, tegulis, abdomine pedibusque posticis rufis, facie, coxis trochanteribusque anterioribus flavis; alis violaceis, stigmate testaceo.

Long. 20 mm.

Head black; the face, clypeus, mandibles, palpi and a short line on the inner orbits above the antennæ yellowish with a fulvous tinge. The front finely rugose; the vertex irregularly reticulated, the inner orbits above, acutely keeled, thickly covered with longish, fuscous hair; the face projects roundly in the middle, is strongly irregularly transversely striated; the clypeus is less strongly punctured, transverse in the middle, its sides oblique. Mandibles yellow, the teeth black, the base of the mandibles punctured, the face sparsely covered with long, fuscous hair. Mesonotum closely, the middle rugosely, punctured; thickly covered with short, fuscous hair; the apex of the mesonotum and the scutellum coarsely transversely striated. Metathorax coarsely and strongly reticulated and covered thickly with fuscous hair. Propleuræ coarsely obliquely striated; its base smooth; the apex above coarsely aciculated. The base of the mesopleuræ strongly obliquely irregularly striated, forming irregular reticulations in the middle; the apex strongly crenulated; the metapleuræ above and below with some stout, transverse keels. Mesosternum finely punctured; the middle deeply furrowed, widest towards the apex; on the basal two-

thirds are five stout, transverse keels. The four anterior legs are fulvous, more yellowish in tint towards the base; the hinder rufous; the apical fourth of the tibiæ black; the metatarsus more than four times the length of the second joint, and twice the length of the four apical joints united; the hinder tarsi are longer than the tibiæ; the claws simple.

This species on the whole fits fairly well into *Heteropelma.* The parapsidal furrows are distinct; the metanotal spiracles I cannot find; those on the petiole are placed near the apex; the metathorax is distinctly narrowed towards the apex; the mandibular teeth unequal, but not conspicuously so; the first recurrent nervure is received in the middle.

HETEROPELMA FULVITARSE, *sp. nov.*

Nigrum; abdomine pedibusque rufis; facie, clypeo, mandibulis palpisque flavis; coxis posticis supra apiceque tibiarum posticarum nigris; alis fusco-hyalinis, stigmate testaceo. ♀.

Long. 17 mm.

Antennæ dark rufous, the basal part of the flagellum darker above. Head black; the face, clypeus, the inner orbits above the antennæ, the mandibles and palpi yellow; the mandibular teeth black; the face and clypeus sparsely covered with long, white hair; coarsely, but not closely, punctured; the front and vertex coarsely obliquely striated; the striæ curved, more closely pressed together above than below. Mesonotum strongly punctured at the sides, the middle irregularly reticulated. Metathorax strongly reticulated. The middle of the propleuræ strongly obliquely striolated; the lower part coarsely, obliquely aciculated; the upper part at the apex, strongly, but not closely, punctured. Mesopleuræ finely and closely punctured, the middle at the apex smooth. Mesosternum

sparsely punctured; the central furrow shallow, much widened towards the apex; across it are four stout, widely separated keels, united by a fine longitudinal one. Legs dark rufous, the four anterior with a more yellowish hue, in front, especially at the base; the hinder coxæ are broadly black above; the apical third of the tibiæ black, the hinder tarsi spinose, the apical joint black, the basal fully four times as long as the second and twice the length of the others united. The first recurrent nervure is received shortly before the middle of the cellule; the transverse median shortly before the transverse basal. Abdomen long; the basal two segments above more or less black.

A smaller and more slender species than *H. reticulatum;* may be known from it by the petiole and hinder coxæ being black above, by the front and vertex being distinctly reticulated, by the apex of the petiole not being abruptly narrowed into a point, but narrowed gradually, and by the much shallower mesosternal furrow.

ANOMALON TINCTIPENNE, *sp. nov.*

Nigrum; abdomine ferrugineo; pedibus anterioribus flavo-testaceis, posticis ferrugineis, dimidio apicali tibiarum nigro; tarsis flavis; alis fulvo-hyalinis. ♀.

Long. 22 mm.

Scape of antennæ thickly covered with long, pale hair; yellowish rufous above; the basal half of the flagellum rufo-fuscous, the apical clear rufous. The face, clypeus, the inner orbits above to the end of the ocelli—the yellow narrowed, almost interrupted, in the middle—a narrow line on the middle behind, the palpi and the mandibles, except the teeth, yellow; the front at the sides stoutly obliquely striated, the middle less strongly and the striæ forming irregular reticulations. The face projects roundly in the

middle, is covered with long, white hair and bears large, distinctly separated punctures; the clypeus is sparsely punctured at the base; the apex impunctate, depressed in the middle. The mandibles at the base are covered with long, white hair. Mesonotum punctured; the middle lobe more strongly than the sides and raised above them; at its base they almost form reticulations, and in the middle of the basal three-fourths is a shallow furrow; on the outer side of the lateral lobes the punctures are more widely separated. Scutellum strongly punctured laterally, the punctures running into reticulations; the middle depressed, the raised sides bordered on the inner side by an indistinct, irregular keel; the sides towards the middle are rufous. Metathorax strongly reticulated; the base and sides thickly covered with pale fuscous hair. The base of the propleuræ aciculated; the upper part of the middle strongly longitudinally striolated; the upper closely punctured; the lower coarsely longitudinally striolated. The base and upper part of the mesopleuræ coarsely irregularly reticulated; the lower closely, but not deeply, punctured; the middle almost impunctate; the apex crenulated, deeply and widely depressed. The extreme base of the metapleuræ is smooth, bordered on the posterior edge above with large, round punctures; below with some stout keels. The four front legs are pale fulvous; the trochanters yellowish; the hinder legs dark ferruginous; the apex of the tibiæ broadly black; the apex of the tarsi inclining to yellow. Abdomen ferruginous; the middle of the petiole infuscated; the second segment black above. Wings hyaline, with a fulvo-fuscous tint; the stigma dark fulvous.

ANOMALON CARINIFRONS, *sp. nov.*

Nigrum; flagello antennarum, pedibus, apice metanoti

abdomineque rufis; facie, orbitis oculorum tarsisque posticis flavis. ♀.

Long. 16 mm.

Scape of the antennæ reddish, yellowish on the under side, the second and third joints deep black; the rest rufous, yellowish on the lower side. Head black; the face and clypeus, a small, somewhat triangular, mark touching the top of the eyes opposite the ocelli, and the outer orbits from shortly above the middle, yellow. Front and vertex closely but not strongly rugose; the inner orbits distinctly margined; above, and between the antennæ, is a stout keel, which becomes gradually wider towards the apex; the face is indistinctly longitudinally keeled; the clypeus is much less strongly punctured than the face and, at the apex, is almost smooth. Mandibles and palpi coloured like the face; the mandibular teeth black; the vertex is thickly covered with short, black hair. Thorax black; the edge of the pronotum at the base, a narrow interrupted line on the sides, a broader line on the side of the mesonotum extending from the middle of the pronotum to behind the tegulae, and the apical half of the metapleuræ, rufous. Mesonotum very closely and uniformly punctured; densely covered with short, black hair; the scutellum is more strongly, and not so closely punctured. The base of the median segment is closely rugose; in the middle are two indistinct keels forming an area, the rest reticulated, thereticulations longer at the sides and apex. The propleuræ at the base minutely punctured and thickly covered with white hair, this part being separated from the rest by a narrow keel; the upper part behind this is rather coarsely punctured, the lower more finely and irregularly striated; the mesopleuræ closely punctured; the middle with an indistinct depression; the lower part at the base irregularly striated. At the

base of the metapleuræ is a smooth, rufo-testaceous depression distinctly bordered on both sides; the oblique depression behind this is wide at the top and rufous in colour; lower down it is narrowed and marked with a few stout keels; the rest coarsely reticulated. The mesonotum is furrowed down the middle, the furrow becoming gradually wider towards the apex and marked throughout with stout transverse keels; on either side of the furrow it is aciculated, more faintly towards the sides, where it has a leaden hue; at the base it is oblique and rufous at the sides; at the apex it is more rounded and not so abrupt. The four anterior legs are fulvous, the coxæ of a more yellowish hue; the hinder legs are of a deeper red; the coxæ without any yellow tint; the apex of the tibiæ broadly black; the tarsi yellowish fulvous. Wings hyaline with a smoky fulvous tint; the stigma fulvous; the costa and stigma darker. Abdomen rufo-fulvous; the second segment black above. The hinder coxæ and trochanters may be slightly marked with black.

CAMPOPLEX FUSCIPALPIS, *sp. nov.*

Niger; abdomine late rufobalteato; tibiis tarsisque anticis testaceis; alis hyalinis. ♀.

Long. 8 mm.

Antennæ black; the apex of the scape testaceous; the flagellum densely covered with a black, microscopic pile; the scape with longish, white hair on the under side. Head entirely black; the middle of the mandibles piceous; the palpi fuscous, and covered with black hair; the face and clypeus closely, uniformly, and rather strongly punctured, sparsely covered with silvery pubescence; the front and vertex punctured like the face; the sides of the front covered with longish, silvery pubescence; the vertex with a much shorter, fuscous pile, Thorax black; the meso-

notum thickly covered with a dark fuscous pile; the scutellum thickly with long, pale hair; the median segment more sparsely with silvery pubescence. Propleuræ closely punctured; the lower part finely longitudinally striated; the lower part of the mesopleuræ at the base shining and marked with a few fine striations; the apex above finely, distinctly and closely striated to near the middle, the striæ slightly curved; the metapleuræ to the spiracles closely punctured; behind them closely irregularly striated. Median segment punctured like the mesonotum; the base from the middle to the apex broadly depressed; the centre more sparsely, the sides more thickly covered with long, white hair. Legs black; the apex of the anterior femora all round and the under side to the middle, the tibiæ and the tarsi testaceous. Wings clear hyaline, the costa and stigma black; the nervures paler; the areolet very shortly appendiculated at the top; the nervures touching; the first transverse cubital nervure straight, the second slightly curved; the recurrent nervure is received almost in the middle of the areolet. Abdomen black; the apex of the second segment, its sides more broadly, the third entirely and the fourth, except above, rufous.

CAMPOPLEX TYRANNUS, *sp. nov.*

Niger; abdomine rufo, petiolo nigro; pedibus fulvo-testaceis; coxis, trochanteribus, femoribus posticis, apice tibiarum posticarum tarsisque posticis nigris; alis hyalinis, nervis stigmateque fuscis ♂.

Long. 9 mm.

Antennæ entirely black; the flagellum covered with short, black pubescence; the scape thickly on the under side with long, black hair. Face and clypeus closely and rather coarsely uniformly punctured, and thickly covered with dark fuscous hair. Teeth of the mandibles rufo-

testaceous; the palpi pale yellow; the part immediately under the antennæ is closely transversely striated. Thorax entirely black; the mesonotum thickly covered with short, fuscous pubescence, the pleuræ and median segment with longer, silvery hair. The propleuræ shining; the upper edges aciculated; the apex bordered by a furrow, narrow at the top, wider and deeper towards the bottom where, in the middle, it is deeply excavated and obscurely striated. The mesopleuræ below the tegulæ strongly longitudinally striolated; the base furrowed from top to bottom, the furrow not reaching quite to the keeled apex of the propleuræ and transversely striated; the upper keels extending beyond the base of the furrow. Mesopleuræ strongly punctured; the oblique depression strongly, and slightly transversely striolated; the apex longitudinally aciculated. Metapleuræ finely rugose; keeled down the middle; the keel sharply bent at the base before the spiracles. Mesonotum closely punctured; the scutellum coarsely rugose, covered with long, pale hair; the sides deeply excavated, smooth; median segment thickly covered with long silvery hair; furrowed down the middle; closely transversely striated. Wings clear hyaline; the areolet petiolated; the transverse cubital nervures curved; the recurrent nervure is received in the apical third. All the coxæ and the four posterior trochanters and the hinder femora black; the fore legs are yellowish; the middle femora of a more rufous tint; the hinder tibiæ thickly spined, rufous; their apex and the hinder tarsi black. Petiole and the second segment above black; the third segment rufous; the others rufous, largely tinged with black.

CAMPOPLEX HIMALAYENSIS, *sp. nov.*

Long. 17-18 mm.

Antennæ entirely black; the scape shining, sparsely

covered with long, black hair; the flagellum thickly with a black, microscopic pile. Front and vertex bearing widely separated, shallow punctures, thickly covered with short, blackish hair; in the centre, between the ocelli, is a shallow furrow; the face and clypeus, except at the apex strongly punctured; the mandibles are coarsely punctured; before the teeth is a large, dirty testaceous mark, which is sharply oblique at the base; the palpi fulvo-testaceous. Thorax entirely black; the mesonotum closely, but not strongly, punctured; on the sides at the apex are two shallow, indistinct furrows; the scutellum is more strongly, more rugosely, punctured; the postscutellum is flat, rugose, the sides carinate. The median segment at the base is finely rugose; from its centre run two curved keels, from the middle of which runs a deep and wide depression to the apex of the segment; the entire apex before the keels is transversely, at the apex more obliquely, strongly striated, and thickly covered with white hair; from near the apices of the two basal keels run stout, curved keels; at the base of this, on the inner side, are two short keels, and on the outer side two longer, oblique ones. The base of the propleuræ strongly aciculated; the hollowed middle strongly obliquely striated; the lower striations stronger than the upper. Mesopleuræ punctured; on the upper edge it is raised; the middle acutely keeled; above the keel, bearing curved striations; below it, at the base, strongly obliquely; the middle with a few stout keels; the apex regularly marked with curved striations; the lower part at the base with stout, longitudinal striations; the apex is depressed, crenulated. The base of the metapleuræ is irregularly rugose; the oblique furrow deep, irregularly crenulated; at the base is an almost smooth, clearly defined, flat, shallow furrow; the upper half is strongly obliquely striated, the lower closely rugosely

punctured, clearly separated from the upper striolated part by an oblique keel. All the coxæ are black, as are also the four posterior trochanters; the anterior tibiæ and tarsi are more yellowish in colour; the hinder femora are broadly marked with black on the under side to the middle; the hinder tarsi are infuscated. Wings uniformly smoky, with a faint violaceous tinge; the transverse cubital nervures unite at the top, but do not form a peduncle; the first is straight, oblique; the second slightly curved. Petiole entirely black, except for a rufous spot on the side near the apex; the second and third segments are broadly black above; the others are narrowly, and not completely, black above.

CAMPOPLEX CARINIFRONS, *sp. nov.*

Long. 14-15 mm.

Similar in the coloration of the body to *C. himalayensis*, but is smaller; has the front distinctly keeled down the centre; the scutellum is more distinctly pyramidal and with the depression at the base larger and deeper; the propleuræ much more strongly and regularly striolated on the lower side on both sides of the depression; the areolet is shortly, but distinctly, appendiculated; and the petiole is only black above.

Antennæ entirely black; the scape punctured, rather thickly covered with longish, black hairs; the flagellum with a microscopic down. Vertex closely punctured, thickly covered with longish, black hair; on the outer sides of the hinder ocelli is a distinct furrow; between them, in the middle, is a longitudinal furrow; the front is depressed; in its centre is a stout, longitudinal keel; the apex of the clypeus has only some large, widely separated punctures; the mandibles have a pale rufo-testaceous hue; the palpi are dark rufo-testaceous; the face is

thickly covered with pale hair. Mesonotum closely and uniformly punctured; its middle lobe slightly raised. Scutellum raised, pyramidal, thickly covered with long, black hairs; the depression at the base deep, the post-scutellum rugosely punctured. The keel on the median segment is curved laterally; at the middle it does not join the base of the segment, being separated by a small, smooth, square area; the part of the sides enclosed by it is closely punctured, the punctures more minute at the base, running at the apex into obscure reticulations; the apex of the segment is broadly depressed in the middle, and strongly transversely striated. The upper part of the propleuræ closely punctured; the lower strongly striated, the striæ rounded and meeting in the middle of the hollow. Mesopleuræ strongly punctured; the part below the tubercles very finely and closely, the base of the hollow more strongly and irregularly, striated. The central furrow on the mesosternum is triangular at the base. Wings smoky, with a violaceous tinge towards the apex; the areolet is narrowed, almost appendiculated at the top; the recurrent nervure is received shortly beyond the middle. All the coxæ and the four hinder trochanters are black; the hinder femora are black in front; the hinder tarsi are blackish. The petiole, second and third segments are broadly black above; the others only narrowly black.

BOSMINA, *gen. nov.*

Wings without an areolet. Spiracles of the metathorax small, oval; those of the petiole placed between the middle and the apex. Claws armed with stout, stiff bristles. Antennæ as long as the body. Eyes roundly, but not deeply, incised on the inner side above. Clypeus not separated. Mandibles with two stout, unequal teeth. Median segment with a double row of distinctly defined

areæ at the base. Petiole long, slender, carinate on the lower side; the ovipositior short. Scutellum not much raised, slightly longer than its breadth, the apex distinctly margined, rounded.

Comes near to *Charops*, with which it agrees in wanting the areolet, but that genus may be known from it by the eyes being deeply emarginate, the scutellum depressed and the antennæ scarcely half the length of the body. Apart from the absence of the areolet it comes near to *Campoplex*, which may be known from it by the much larger and more elongated spiracles. The spiracles are more oval than in *Limneria*, and the median segment has the areæ more numerous and more distinct.

BOSMINA SPINIPES, *sp. nov.*

Nigra; scapo antennarum, pedibus abdomineque rufis, tegulis, coxis anticis trochanteribusque flavis; alis hyalinis, nervis stigmateque fuscis. ♀.

Long. 8 mm.

Scape of antennæ sparsely covered with long, pale hair; the flagellum thickly covered with short, black hair. The face and clypeus thickly covered with long, silvery hair; the base of the mandibles broadly, and the palpi pallid yellow; the base of the mandibles covered with long, golden hair; the vertex closely, the front more strongly, punctured and keeled down the middle; the outer orbits covered with long, silvery pubescence. Thorax entirely black; the mesonotum closely punctured; thickly covered with a short, black pile; the pleuræ and median segment thickly with longish, silvery hair. On the middle of the propleuræ are stout, curved, distinctly separated keels; there is a striated space on the middle of the meso-pleuræ, the striæ strong at the base, minute at the apex; the metapleuræ are more strongly punctured than the

mesopleuræ; the spiracular region is bounded by two keels and is strongly transversely punctured. The tibiæ and tarsi are spinose, the coxæ thickly, the femora more sparsely covered with shorter, white hair. The petiole is black, except at the apex; the second segment has the basal third black; the sheaths of the ovipositor black. On the median segment there are five clearly defined areæ, besides a small central one at the base; the spiracular region has two complete keels; the tibiæ and tarsi are more strongly spinose than usual; the spines on the claws are stout.

TRATHALA, *gen. nov.*

Wings without an areolet. Claws pectinated. Metathoracic spiracles oval. Spiracles of first abdominal segment small, round, placed behind the middle. Clypeus separated from the face, and with a large fovea on either side at the base. Mandibles large; the teeth subequal. Head not dilated behind the eyes. Median segment distinctly areolated. Wings short; the recurrent nervure is received on the outer side of the first transverse cubital; the transverse basal nervure is interstitial. Abdomen long, compressed, and with a long ovipositor. Eyes bare, not reaching to the base of the mandibles. Scutellum convex, its sides and apex coarsely striolated. The apex of the clypeus rounded. Parapsidal furrows only indicated at the base of the mesonotum.

This genus comes near to *Campoplex*, from which it differs in the absence of an areolet, in the transverse basal nervure being interstitial, in the greatly elongated ovipositor, and in the median segment having distinct areæ.

TRATHALA STRIATA, *sp. nov.*

Nigra; pedibus abdominisque apice rufis; coxis trochan-

teribusque anterioribus flavis; alis hyalinis, nervis stigmateque nigris. ♀.

Long. 15; terebra 10 mm.

Antennæ black, the scape yellow, black in the middle above. Head black, the inner orbits from opposite the lower ocellus, the face, clypeus, palpi and mandibles, yellow; there is a large black mark on the face below the antennæ; the mandibular teeth are black; the face and clypeus are strongly punctured. The vertex is punctured, but not closely or deeply; the front is more shining and transversely striated. Thorax closely and strongly punctured; the scutellum is, if anything, more strongly punctured than the mesonotum; the sides and apex are strongly striated, the striæ distinctly separated and extending to shortly below the middle, the lower space being smooth. The postscutellum is represented by a semi-circular keel, the part between being hollowed; behind, it is rugose. Pleuræ strongly and closely punctured; the middle of the mesopleuræ is longitudinally striated; behind the striations, smooth; on the lower side of the mesopleuræ and extending to the middle is a striated furrow. On the median segment are two central areæ; the basal being the shorter; its base is transverse in the middle; it becomes obliquely wider, then becomes gradually narrowed, the keels bounding the narrowed part being slightly curved, not straight like the basal; its apical half is transversely striated; the apical area is more strongly transversely striated. The basal outer area is closely and finely punctured; the apical is transversely rugose; the spiracular area is distinctly defined, of equal width throughout, and is closely transversely rugose; its apex is rounded and ends opposite the base of the middle coxæ; behind it is a narrow area, reaching to the hinder coxæ; inside, this area is coarsely rugose. The basal and

apical divisions of the radius are oblique; the apical (and larger) is not quite so straight; the recurrent nervure is largely bullated at the top. The wings do not reach much beyond the apex of the second abdominal segment. The petiole entirely, the second abdominal segment above, and the base of the third, are black; the rest rufous; the petiole is smooth at the base; beyond the middle are some scattered punctures; the sides above before the apex are finely and closely striated; the second segment above is closely and finely longitudinally striated, except at the apex, which is smooth; the basal portion of the third segment is similarly striated; in the middle above, these two segments are depressed.

LIMNERIA BUDDHA, *sp. nov.*

Nigra; abdomine rufo, petiolo nigro; pedibus rufis; trochanteribus coxisque anterioribus flavis; alis hyalinis, stigmate fusco. ♀.

Long. 7; terebra 2 mm.

Scape of the antennæ yellow, blackish above, below covered with long, pale hair; the flagellum thickly covered with short, black hair. Head black; the mandibles and palpi yellow; the mandibular teeth black, piceous at the base. The face and clypeus closely uniformly and rather strongly punctured, thickly covered with fuscous and silvery pubescence; the front and vertex less strongly punctured than the face and more shortly and sparsely pilose. Thorax black, closely punctured; the mesonotum sparsely covered with short fuscous; the rest more thickly with longer, silvery hair. The scutellum is less strongly punctured than the mesonotum; the depression at its base covered in the middle with longish, white hair; the post-scutellum with a round, deep fovea on either side; the part at the sides of it very smooth and shining. Median seg-

ment closely punctured; the apex in the middle transversely striated; the central keel longish; the lateral roundly curved. Propleuræ closely punctured, running into longitudinal striations; the mesopleuræ closely punctured; the oblique depression, in the middle behind, finely striated; the metapleuræ similarly punctured; the curved keel in the centre is stout, attenuated at the apex. The four anterior legs are fulvous, the trochanters and coxæ yellow; the hinder legs darker, more reddish, in tint; the coxæ, the base and apex of the tibiæ and the tarsi blackish; the calcaria yellow. The petiole is black; the basal half distinctly narrowed; the basal three-fourths of the second segment black; the apex rufous; the base of the third is black in the middle; the ventral surface yellowish in the middle; the sheath of the ovipositor black.

LIMNERIA INDICA, *sp. nov.*

Nigra; abdomine pedibusque rufis; coxis petioloque nigris; alis fusco-hyalinis. ♀.

Long. 7 mm.

Antennæ black, thickly covered with white pubescence; the scape yellowish at the apex beneath. Head black; the eyes on the inner side distinctly margined; the face closely, but not strongly, punctured; thickly covered with short, silvery pubescence; the mandibles and palpi lemon-yellow; the mandibles piceous black at the apex; the vertex on the lower side close to the eyes faintly transversely striated. Thorax entirely black; covered with a sparse, white pubescence; the top, at the base, and the hinder part of the propleuræ closely striated; the mesopleuræ closely punctured; the middle above with an oblique, shallow depression; the part in front of it being obscurely transversely striated; behind more shining than elsewhere. Median segment

closely punctured, thickly covered with short, white pubescence; the base is more finely punctured than the rest; is keeled down the middle, and, from the apex of this central keel, run two curved keels, which do not curve backwards to the base of the segment; below the spiracle is a curved keel, straight and oblique at the base, curved towards the apex of the segment. Wings hyaline; the nervures fuscous, the stigma slightly darker; the areolet is oblique, small, shortly petiolated at the top; the recurrent nervure is received shortly beyond the middle. All the coxæ are black, except at the apices, where they are pale yellow, as are also the four anterior trochanters; the four anterior femora, tibiæ and tarsi are also paler, not so reddish as the posterior; the hinder tibiæ are sparsely spinose; the tarsi infuscated. Abdomen ferruginous; the petiole black, except at the apex; the ventral surface yellowish; the sheaths of the ovipositor black.

LIMNERIA VOLENS, *sp. nov.*

Nigra; abdomine rufo, basi late nigro; pedibus fulvis; coxis trochanteribusque anterioribus flavis; coxis posticis nigris; alis hyalinis, stigmate testaceo. ♀.

Long. 7 mm.

Antennæ black; slightly thickened towards the apex; the scape covered with white hair; the flagellum with pale down. Face and clypeus coarsely shagreened; sparsely covered with short, white hair; the front and vertex opaque; the mandibles and palpi pallid lemon-yellow; the apices of the mandibles black and piceous. Thorax black, opaque, the pleuræ and metanotum covered with white pubescence. The propleuræ not excavated, the base broadly raised; coarsely shagreened; the lower part in the middle strongly transversely striated; the mesopleuræ strongly aciculated, except in the middle

behind; the base on lower side curved, distinctly margined; the apex strongly crenulated; in front of the middle coxæ is a short, oblique furrow; the metapleuræ coarsely aciculated; at the base, below the spiracles, is a short depression. On either side of the postscutellum is a round fovea, clearly margined; the part on either side of the postscutellum is longitudinally striated. The base of the median segment is raised and sharply separated from the postscutellum; the segment itself is coarsely shagreened; the curved keel is widely separated from the base, and, behind it, is an interrupted, longitudinal one; the keel bordering the apex is indistinct at the top. Legs rufous; the four anterior coxæ and trochanters pale yellow; the hinder coxæ and the basal joint of the trochanters above, black; the hinder tarsi infuscated. Wings clear hyaline; the stigma fuscous; the nervures paler; the areolet small, shortly appendiculated; the lower half of the second transverse cubital nervure largely bullated, almost obliterated; the recurrent nervure is largely bullated above and is received in the apical third of the areolet. The petiole and the upper side of the second segment, except the apex, black; the ventral surface yellow; the sheaths of the ovipositor black.

This species is nearly related to *L. indica*, which differs from it in being larger; in having the four anterior coxæ black, except at the apex; in the second segment being without black; in the apex of the median segment not being bordered by a keel; in the areolet being more distinctly appendiculated, &c.

PIMPLIDES.

RHYSSA FULVIPENNIS, *sp. nov.*

Nigra, flavo-variegata; antennis pedibusque fulvis; alis fulvo-fumatis, stigmate testaceo. ♀.

Long. 38-39; terebra 65 mm.

Antennæ fulvous; more yellowish in tint about the middle; the scape shining, almost bare. Head fulvous, the face paler, more yellowish; the front and vertex to the end of the ocelli, a band extending from the latter to the occiput and of the width of the ocellar region, and a band on the upper part of the occiput, black. Mandibles black, as is also the part behind the clypeus. The projecting part of the face punctured, but not strongly; the sides quite smooth; the pubescence sparse, fuscous; the front and vertex are obscurely punctured, smooth, almost glabrous. Mesonotum black; sparsely pilose; on the base of the middle lobe is a somewhat ∧-shaped fulvous mark; there is a similarly coloured line in the middle on the inner side of the middle lobe, and a shorter line alongside the tegulæ. Scutellum finely, transversely punctured; pale fulvous yellow; a large, somewhat oval, black mark at its base, and a somewhat triangular one at the apex; postscutellum shining, pale fulvous yellow, broadly black in the middle. Median segment smooth and shining; at its base in the centre is a large, deep depression, broader than long, and having at the sides some longitudinal keels. Propleuræ very smooth and shining; the upper part is occupied by a large, pale fulvous mark, which, posteriorly, is prolonged downwards to shortly below the middle; the basal part at the base is similarly, but more narrowly, coloured, from the middle on the basal part to near the end on the lower side; the apex is depressed and crenulated. Mesopleuræ finely punctured, the apical furrow narrow, crenulated; the tubercles and a large mark occupying the greater part of the pleuræ posteriorly, fulvous yellow; this mark is slightly oblique, longer than broad, the top straight at the base; the apical part oblique; the upper part above conically indented. Legs rufous; the posterior tarsi slightly yellowish; the four anterior

coxæ and trochanters yellow; the posterior coxæ of a darker rufous than the femora, and marked with black at the base; behind, at the base, is a small, yellow mark. Wings deep fulvous; the apex slightly infuscated; the costa and stigma fulvous; the nervures black; the areolet triangular; the first transverse cubital nervure oblique, straight; the second curved; the recurrent nervure is received in the apical fourth of the areolet. Abdomen shining; the petiole rufous; the other segments dark rufous; the second segment above marked with two broad, obscure fulvous lines; the others marked laterally with fulvous lines, broad at the base, becoming obliquely narrowed towards the apex; the basal ventral segment rufous; the others yellowish; the sheaths of the ovipositor dark fulvous towards the apex.

EPIRHYSSA FLAVO-BALTEATA, *sp. nov.*

Fulva, flavo-maculata; antennis rufo-testaceis, apice nigris; alis fulvo-hyalinis, apice fusco-maculatis, stigmate rufo-testaceo. ♀.

Long. 13-22; terebra (in large size) 25 mm.

Antennæ dark rufous, darker towards the apex; the scape yellowish beneath. The lower half of the front and the face yellow; the vertex behind the ocelli rufous; the face closely punctured, thickly covered with short, white hair; the clypeus short, the sides at the apex rounded; the base with a trilobate depression, the central lobe curved, the lateral smaller and much deeper. Mandibles short and broad, the basal half rufous, the apical deep black; the palpi pale yellow. Thorax yellowish; the mesonotum dark rufous; black in the middle beyond the central lobe; the central lobe raised, its base with an almost perpendicular slope, and black on the lower part;

the striations are stout; on the apex, bordering the central black band, is an obscure yellow one. Scutellum yellow, black at the apex; transversely striated. Post-scutellum smooth, lemon-yellow, bifoveate at the base. The base of the median segment deep black, shining, broadly depressed in the middle; at the base are two transverse keels; the segment has a rounded slope, and is covered with shallow, clearly separated punctures; the apex almost impunctate and deep black; the middle has a deep and wide furrow, which does not extend into the apex. Propleuræ punctured; the middle obliquely depressed, black on the basal half, and smooth; the extreme apex black, and coarsely punctured; the extreme base of the mesopleuræ black; below the tubercles is an oblique, blackish band, from which another, broader and less oblique, runs to the bottom; the tubercles are large, longer than broad, depressed at the base and apex; the apical furrow is crenulated. The base and apex of the metapleuræ depressed and black; below the spiracles is an oblique keel. The mesosternum closely and strongly punctured, with a wide, stoutly transversely striated furrow down the middle. Legs yellow; the femora with a rufous tinge; the hinder coxæ darker in front; the tarsi (especially the hinder) infuscated. Wings fulvo-hyaline; the stigma dark rufous; the nervures darker; on the apex of the radial and the second cubital cellule is a fuscous cloud; the recurrent nervure is interstitial. Abdomen dark rufous; the apices of the segments broadly yellow; the basal two segments are slightly and widely punctured; the middle much more closely and strongly; the apical closely, but not so strongly, and thickly covered with fuscous hair.

The amount of the black and yellow colour varies, as does also the size.

EPIRHYSSA CARINIFRONS, *sp. nov.*

Nigra; facie, orbitis oculorum, linea pronoti late, scutello, postscutello apiceque metanoti flavis; abdomine flavomaculato, apice brunneo; pedibus fulvis, basi flavis; tarsis fuscis; alis hyalinis, apice fumatis, stigmate fusco. ♂.

Long. 11 mm.

Antennæ rufous, thickened and infuscated towards the apex; the flagellum covered thickly with stiff, microscopic hair. The face yellow, covered with large, deep punctures and with long, white hair; the clypeus smooth, bare, its apex transverse. Front depressed; from the ocelli a distinct keel runs to the base of the antennæ; it is yellow, with a black line in the middle; the vertex is black; the black extending as a triangular mark on to the front on either side of the keel, and extending to the eyes at the ocelli; the occiput is black round the upper edge, the black extending down the middle as a broad band. Mandibles black, the basal half rufous; the palpi yellow. Thorax black; the scutellum, postscutellum, a broad band near the middle of the median segment, extending near to the apex, and on the pleuræ extending to near the spiracles; the upper part of the propleurae broadly, and the prosternum, lemon-yellow. The mesonotum is covered with fuscous hair; the scutellum coarsely punctured, covered with long, fuscous hair; the postscutellum smooth; the scutellar keels are yellow. Metanotum smooth at the base; the middle depression deep and wide, smooth; the rest of the segment bearing shallow punctures and sparsely covered with white hairs. The propleuræ, except above, impunctate; the mesopleuræ sparsely punctured, except at the apex; the tubercles large and thickly covered with long, white hair; the mesosternum coarsely punctured; smoother in the middle at the apex, where there is a depression which becomes

gradually wider towards the apex; the metasternum smooth. Wings hyaline, with a faint fulvous tinge, a fuscous cloud occupies the apex of the radial and the greater part of the second cubital cellule; the costa and stigma rufo-testaceous; the nervures darker, paler towards the apex. Abdomen dark rufous, the apices of the basal four segments more or less yellowish, the second and following segments broadly black at the base; the petiole smooth; the others closely punctured, and covered (especially the apical) with short, fuscous hair. The four anterior legs yellowish, the femora fulvous behind; the hinder coxæ black, broadly yellow in the middle behind; the femora dark fulvous; the tibiæ and tarsi fulvous, but lighter in tint than the femora.

EPIRHYSSA MACULICORNIS, *sp. nov.*

Flava, nigro-maculata; antennis nigris; alis hyalinis, apice fumatis; terebra corpore longiore. ♀.

Long. 15; terebra 20 mm.

Antennæ black, slightly thickened towards the apex; the basal joints of the flagellum brownish beneath; the apical joints brownish red. Head yellow; a broad, black line extending across the ocelli from eye to eye, and behind them in the middle roundly dilated to the edge; in front of them projecting squarely to half way down the front, which is punctured closely but not strongly; the clypeus at the sides impunctate; the middle obscurely transversely striated; the mandibles, and the space between them and the eyes black; the lower part of this black part being smooth, the upper aciculated. Mesonotum black, except at the tegulæ, and a large mark in the middle, longer than broad, transverse at the base and with the sides straight; the transverse striations stronger and somewhat more widely separated laterally. Scutellum finely

closely transversely striated; the extreme apex in the middle black. Postscutellum black, smooth, shining, impunctate. The base of the median segment narrowly black; its middle smooth, broadly furrowed; the sides closely punctured; the apex with a broad semicircular black band. Pro- and meso-pleuræ shining, smooth; the base of the meso- broadly, its apex more narrowly on the lower side, black; the metapleuræ obscurely punctured in the middle; the base and apex lined with black. Mesosternum narrowly, but rather deeply, furrowed down the middle, laterally marked with two transverse rows of fuscous lines. Except for the apical fuscous cloud, the wings are hyaline; the costa, stigma and nervures black; the recurrent nervure interstitial; the transverse median nervure is received distinctly behind the basal nervure, Legs yellow like the body; the apex of the hind coxæ broadly, the base of the hinder tibiæ and the apices of the tarsi, black. Abdomen shining; the bases of the segments narrowly, their apices more broadly, black; the black part on the apices impunctate; on the base punctured like the rest of the segments; the apical segments only black in the middle.

EPIRHYSSA ANNULICORNIS, *sp. nov.*

Cœrulea, fulvo-maculata; antennis nigris, medio late albolineatis; pedibus fulvis, tarsis posticis albis; alis hyalinis, basi albis, stigmate nigro. ♀.

Long. 17; terebra fere 15 mm.

Antennæ slender, thickly covered with a black, microscopic pile; the scape testaceous beneath; there is a long, white band beyond the middle; the apex itself is broadly white, except the terminal joint, which is black. Head shining, blue; the cheeks broadly, the sides of the clypeus more narrowly (and with the yellow obliquely

narrowed from the top to the bottom), a broad line on the inner orbits from the base of the antennæ to the middle of the ocelli, narrowed and rounded at the base and apex and the outer orbits on the lower side broadly, yellow. The face rather strongly punctured; the clypeus black; obliquely depressed at the base; almost impunctate, thickly covered with long, fulvous hair; the palpi yellowish testaceous. Mandibles black, finely punctured at the base; the apex with only the rounded apical tooth. Mesonotum closely punctured; the apical three-fourths irregularly and distinctly reticulated, the reticulation being continued half-way up the raised basal portion as a narrow line; the lateral lobes are furrowed down the middle, the furrow shallow and abruptly narrowed near the apex. Scutellum closely punctured; the apex flat, with a distinct inner, and a more distinct outer, keel; the apex with a transverse keel immediately before its termination; the postscutellum roundly depressed at base and apex; the sides stoutly keeled. The central areæ on the median segment united; the basal part curved inwardly and narrowed; the apical with the sides straight; the lateral keel roundly curved on the inner side of the spiracles; the part on its inner side crenulated; the basal half shagreened; the apical half in the centre strongly, the sides less strongly, transversely striated. Propleuræ shagreened; the top strongly, the apex less strongly crenulated; the lower side smooth, broadly furrowed; the lower side of the furrow with a narrow keel, there being another keel over the prosternum; there being also a perpendicular keel at the base. Mesopleuræ shagreened; thickly covered with pale fulvous hair; its apex depressed, crenulated; the metapleuræ coarsely shagreened above, the rest irregularly longitudinally striolated. Wings hyaline, slightly infuscated along the transverse cubital and recur-

rent nervures; the latter is received immediately on the outside of the transverse cubital, almost touching it; the stigma is white at the base, fuscous on the lower side. Legs fulvous; the hinder tarsi white, except the apical two joints, which are black; the base of the middle coxæ, the hinder except for a fulvous mark at the base above, and the middle beneath, the hinder trochanters, base and apex of femora narrowly, the extreme base of the tibiæ and their apex more broadly, black; the hinder femora with a distinct bluish tint. The petiole is distinctly longer than the second segment, yellowish; a broad, bluish band, near the middle, closely and coarsely punctured; the apex more or less reticulated, and, in the middle, transversely striated, and with a central and two lateral narrow keels leading into an impunctate spot at the apex. The second segment broadly blue at the base, the apex more narrowly black; at the base, on either side, is a deep, oblique depression; at the base, in the middle, is a somewhat Λ-shaped depression, deep at the base, shallower, wider, and obliquely striated at the apex; at the apex, on either side, is a wider, shallower, oblique depression, narrowed and deep at the base, becoming wider and shallower towards the apex. Near the base of the third is a wide, shallow, semicircular depression, with a narrow, straight keel in the middle at the base, and with its sides obscurely striated; the other segments smooth, whitish at the apices. The petiole beneath is black at the base, and irregularly marked with semicircular striations; its apex, and the second and third segments in the middle, testaceous.

EUGALTA, *gen. nov.*

Wings with or without an areolet. Mandibles meeting at the apex, large, with only one apical tooth.

Clypeus not separated from the face by a suture. Eyes large, reaching near to the base of the mandibles; the upper orbits margined. Mesonotum trilobate, reticulated in the middle at the apex. Metathorax elongate, with a gradually rounded slope to the apex; the spiracles placed near the middle, oval. Legs elongate, slender, the hinder tarsi large, elongate, smooth, or striated on the outer side; the hinder tarsi nearly equal in length to the tibiæ; the claws with a stout basal tooth, shorter than the other, which is curved and thinner; coxæ large, elongate. Abdominal segments smooth; the petiole longer than the second segment, gradually widened towards the apex; the other segments not much broader than their length, smooth; the gastrocœli distinct; the ovipositor long, issuing from a ventral cleft. The spiracles are small, oval, almost round, and are placed near the middle of the segment.

This genus is nearly allied to *Rhyssa* and *Epirhyssa*, which differ from it in the transversely striated mesonotum, in the shorter metathorax, in the mandibles being bidentate, in the shorter petiole, which has the spiracles placed much nearer the base, and in the longer hinder tarsi, which are distinctly longer than the tibiæ.

A. *Areolet absent.*

EUGALTA STRIGOSA, *sp. nov.*

Nigra; facie, annulo antennarum, pedibus anterioribus, trochanteribus posticis, dimidio basali tibiarum posticarum tarsisque posticis albis; thorace rufo; alis hyalinis, nervis stigmateque nigris. ♀.

Long. 20; terebra 20 mm.

Antennæ black; the base of the flagellum underneath, and a broad band in the middle, white. The face and

clypeus white, strongly punctured, sparsely covered with long, fuscous hair; the mandibles deep black; the palpi white; the clypeus broadly depressed in the middle. The front slightly depressed, smooth; the orbits sharply margined on the inner side; the vertex on the sides behind strongly punctured. The occiput sharply margined above; raised in the middle, closely punctured. Thorax rufous, above covered with fuscous, the sides with longer white, hair; elongate, fully three times as long as the head; the metathorax large, and with a gradual slope to the apex. The middle lobe of the mesonotum small, triangular, not narrowed at the apex, where it is transversely striated, roundly raised and distinctly separated from the lateral; closely punctured; the bordering furrows crenulated; the lateral lobes strongly punctured; the middle to near the apex stoutly reticulated. Scutellum punctured, irregularly reticulated in the middle; its apex obscure yellow, its border margined on the lower side. Postscutellum coarsely punctured, the base smooth and with an oblique slope, rufous; the rest pallid yellow like the scutellum. Median segment irregularly transversely striated, the basal three-fourths with a shallow furrow down the middle; the apex is pale yellow, with a transverse keel near the base of the yellow part. Propleuræ smooth; the apex near the tegulæ punctured; the lower part with a purple tinge; the prosternum yellowish. Mesopleuræ punctured; the base above and the middle irregularly striated, the former obliquely. Below the middle of the tubercles is a wide, oblique furrow, which becomes narrowed towards the apex; the part below this is raised; at its apex is a smooth space. Mesopleuræ punctured, the centre smooth, with a narrow furrow down it. Metapleuræ rugosely punctured; the upper part especially towards the apex. The four anterior legs are

whitish yellow; the coxæ and femora are lined above with black; the hinder coxæ are more broadly black above; the trochanters are black above; the femora almost entirely black; the tibiæ black, white at the base to near the middle; the tarsi white. Wings hyaline, with a slight fulvous tinge; the stigma and nervures black; the recurrent nervure is received about its length in front of the transverse cubital. Abdomen black; the segments lined with white at their apices, the white lines dilated in the middle. Petiole transversely striated, more coarsely on the basal half; the apical half furrowed down the middle; its sides at the end punctured; the second segment is strongly, the third less strongly, punctured; the others shagreened; the gastrocœli are smooth and deep; the base on the outer side of the segments projects; on the sides of the third segment is a narrow depression.

EUGALTA ALBITARSIS, *sp. nov.*

Nigra; annulo flagelli antennarum late, tegulis, coxis tarsisque albis; femoribus posticis basique tibiarum posticarum fulvis; alis hyalinis, nervis stigmateque nigris. ♀.

Long. 11; terebra 6 mm.

Antennæ black; the ninth to seventeenth joints white; the scape pale fulvous beneath. Head black; the face and palpi yellowish white; the clypeus dark brownish; depressed in the middle near the apex, which is rounded. Front and vertex smooth, shining, almost bare, plumbeous black; the inner orbits above distinctly margined; the face covered with long, white, the clypeus more thickly with longer, pale fulvous, hair. Mandibles black. Thorax black; the propleuræ plumbeous; its lower edge, the tubercles and tegulæ, white. Mesonotum closely and rather strongly punctured; its apex in the middle transversely striated, depressed. Scutella closely punctured;

the postscutellum not much depressed at the base; the depression at its side strongly longitudinally striated. Median segment closely and uniformly reticulated and sparsely covered with fuscous hair. Mesopleuræ closely punctured; a longitudinal depression under the tubercles, a perpendicular one in the middle and a wider oblique one nearer the apex, which is depressed and crenulated. Metapleuræ closely reticulated; the lower side at the base furrowed widely and deeply. The front coxæ white, broadly black behind; the femora and tibiæ whitish, the former fulvous behind; the middle coxæ white, with a black mark on the sides at the apex; the femora obscure fulvous, infuscated in front; the tarsi and the apex of the tibiæ broadly blackish; the large hinder coxæ broadly black on the apical two-thirds, the apical joint of the trochanters, the apical three-fourths of the femora above, the tibiæ, except at the base, and the apex of the tarsi, black. Wings hyaline, iridescent; the nervures and stigma black. Abdomen black; the base and apex of the petiole, the sides of the second segment at the apex, a narrow band on the apices of the fifth and sixth and the seventh segment broadly, yellow. Petiole transversely rugose; the second segment strongly and closely punctured; the second to fourth ventral segments testaceous.

B. *Areolet present, small.*

EUGALTA SPINOSA, *sp. nov.*

Long. 19 mm. ♀.

Agrees closely in coloration with *E. albitarsis*, but differs in having the median segment entirely black; in the complete areolet; in the base of the postscutellum being rounded, not depressed, and with the sides margined; in the median segment not being furrowed at the base; in

the base of the petiole being broadly white; and in having on its under side, near the base, a curved sharp tooth.

Antennæ black; the under side of the scape, and a broad band beyond the middle, white; the scape on the under side covered with pale fulvous hair; the flagellum thickly with a microscopic pile. Head black, with a distinct plumbeous hue; the face, the inner orbits to opposite the lower part of the ocelli, the outer orbits on their lower two-thirds and the palpi, yellow. The front and vertex smooth and impunctate, almost bare; there is a furrow between the ocelli; behind the eyes is an obscure rufous patch. Face shining, smooth, sparsely covered with long, fuscous hair. Clypeus obscure rufous (perhaps discoloured), smooth; the apical two-thirds depressed; its apex depressed, rounded at the sides. Mandibles smooth, black, rufous at the base. Thorax dark rufous; the apex of the mesonotum, the median segment above, and the apical half of the metapleuræ, black; the greater part of the propleuræ plumbeous-black. Mesonotum closely punctured; the sides of the raised basal lobe irregularly striated; the depressed apical central part black, and strongly irregularly transversely striated; thickly covered with long, fuscous hair, most densely on the basal lobe. Scutellum punctured, sparsely covered with long, fuscous hair. Postscutellum strongly punctured, except at the apex; the base not depressed; the sides not margined. The lateral scutellar depressions strongly striolated. Propleuræ very smooth and shining; punctured above. Mesopleuræ closely punctured; the tubercles coarsely punctured; the upper part of the base strongly, somewhat irregularly, striated; the apex in the middle smooth. Metapleuræ rugosely punctured, the punctures running into reticulations at the apex and under the wings. Mesosternum shining, thickly covered with long,

white hair. The four anterior legs whitish yellow; the coxæ and femora lined with black behind; the hinder coxæ black above; the apical joint of the trochanters, the femora and the apical half of the tibiæ, black. Wings hyaline, with a fulvous tinge; the stigma and nervures black; the areolet small, almost appendiculated above through the nervures uniting; the second transverse cubital nervure bullated below; the recurrent nervure is received in the apical third of the cellule. Abdomen black; the apices of all the segments, and the base of the petiole more broadly, yellow; the petiole has the basal half rough, the apex smooth; the spine on the under side is broad at the base, curved and narrowed towards the apex; the second and following segments are closely punctured; the sheaths of the ovipositor thickly covered with short, black hair.

EUGALTA NIGRICOLLIS, *sp. nov.*

Nigra; facie, tegulis, scutello, lineisque abdominis flavis; pedibus flavis; dimidio apicali tibiarum posticarum nigro; alis hyalinis, stigmate testaceo. ♂.

Long. 15 mm.

Antennæ absent. Head black; the face and a triangular spot between the antennæ, yellow; the face thickly covered with short, silvery hair; obscurely punctured; the clypeus black, smooth, its apex roundly curved; mandibles deep black. Thorax black, with a distinct plumbeous hue; the mesonotum shining, impunctate; the depressed apex in the middle with four oblique keels on each side, the middle the longer. Scutellum slightly rough, thickly covered with long, white hair; the post-scutellum smooth. Median segment uniformly and closely reticulated; thickly covered with long, white hair. Pro- and meso-pleuræ smooth and shining, impunctate, sparsely

covered with pale hair; metapleuræ above strongly reticulated, the lower part closely reticulated, the reticulations running into punctures; the apex with the reticulations larger. The four anterior legs whitish yellow; the coxæ black behind; the posterior legs have a more decided fulvous tinge and are broadly marked with black on the apical half above; the apical joint of the trochanters, except at the base beneath; the apex of the femora, and slightly more than the apical half of the tibiæ, black. Wings hyaline; the nervures black on the basal part; the apical and the stigma testaceous. Abdomen black, shining, smooth; the base of the petiole broadly, its apex more narrowly, and the apices of the other segments broadly, whitish-yellow. The petiole is oblique, shortly appendiculated above; the recurrent nervure is received in its apical third.

EUGALTA PUNCTULATA, *sp. nov.*

Long 12; terebra 10 mm.

Comes nearer to *E. nigricollis*, but is smaller, and has the mesonotum distinctly punctured; the clypeus semicircularly depressed at the apex; the petiole shorter; the second segment closely and rather strongly punctured; the hinder tibiæ black, broadly yellow at the base and apex.

Scape of antennæ black, yellowish beneath; the base of the flagellum black—the rest broken off. Head black; the face yellow, the clypeus testaceous, darker in the centre, the palpi yellow. The face shining, projecting in the middle, covered with shallow punctures and with long, pale hair; the clypeus with a raised, broad, semicircular border at the base, forming a semicircular hollow in the middle. Mandibles black, piceous at the base. Front depressed; the inner orbits margined; the outer

orbits sharply project; and are marked above with stout, oblique keels. Thorax black; the tegulæ, tubercles and a line on the apex of the mesopleuræ, yellow. Mesonotum strongly and closely punctured, as is also the scutellum, which is yellow, black at the base, and thickly covered with fuscous hair. Postscutellum almost impunctate and glabrous, yellow. Median segment above reticulated, at the apex, in the middle, the reticulations are wider; at the sides closer. Propleuræ plumbeous, smooth and shining; the lower part yellow, broad at the base, narrowed at the apex. Mesopleuræ shagreened; closely and finely punctured at the base of the tubercles; the metapleuræ closely reticulated and thickly covered with long, white hair. Mesosternum impunctate, furrowed down the middle. The four anterior legs yellow; the coxæ lined behind with black; the four apical joints of the front and the whole of the middle tarsi, black; the hinder coxæ are broadly black above; the apical joint of the hinder trochanters, the apex of the femora, which are fulvous, the hinder tibiæ black, with a narrow white band near the base and the apical third, white; the hinder tarsi white, except the apical two joints which are black. Wings hyaline, irridescent; the stigma and the apical nervures fuscous, the costa and the basal nervures black; the areolet small, oblique, shortly appendiculate; the recurrent nervure is received in its apical third. Abdomen black; the base of the petiole, its apex more narrowly and the apices of the other segments, yellow; the petiole smooth, obscurely shagreened in the middle; the second and third segments closely and distinctly punctured, the others impunctate; the gastrocœli shallow, indistinct, finely and closely punctured. The base and apex of the petiole beneath yellow; the sides at the apex depressed; at the base in the centre is a stout tooth, which is rounded in the middle.

LYTARMES, *gen. nov.*

Mesonotum transversely striated, trilobate, the middle lobe only distinct in front. Clypeus separated from the face, its sides at the base depressed. Mandibles short, thick, bidentate at the apex. The head not much dilated behind the eyes. Areolet appendiculate, the appendicle as long as, or shorter than, the cellule itself; the latter is rounded at the top. The transverse median nervure is received in front of the transverse basal. The recurrent nervure is received near the base of the areolet. The radial cellule elongate, lanceolate at the base and apex. Scutellum flat; the median segment has a gradual slope to the apex; the spiracles are large, elongate, rounded at the base and apex. Abdomen without depressions, smooth; the petiole shorter than the second segment; the spiracles are oval, oblique, and are placed near the base. Legs stout; the hinder coxæ large, of equal width, not swollen; the tarsi spinose; the claws simple; the hinder tibiæ and tarsi subequal. The intermediate abdominal segments are not longer than their breadth; the segments are aciculate and not emarginate or grooved at the apex; in the ♂ they are convex above. The meta- is shorter than the meso-thorax. The last joint of the hinder tarsi is about three times as long as the penultimate.

The first recurrent nervure is received shortly before the middle of the cellule; there is a short nervure on the cubital nervure, before the areolet, as in *Ichneumon*. Except in the form of the abdomen the ♂ does not differ from the ♀.

This genus has the striated mesonotum of *Rhyssa*, but differs from it in the appendiculated areolet and in the abdominal segments being not distinctly longer than their breadth, in the shorter hinder tarsi compared with the tibiæ, in the much shorter hinder coxæ, and in the head being less developed behind the eyes.

LYTARMES MACULIPENNIS, *sp. nov.*

Niger, brunneo-maculatus; facie orbitisque oculorum flavis; alis fusco-hyalinis, macula substigmatali fumata; pedibus rufo-brunneis. ♀.

Long. 16; terebra 21 (?) mm.

Antennæ not quite so long as the body; the scape yellowish below, reddish above; the base of the flagellum ferruginous; the apical part blackish. Head: the face and clypeus, the inner orbits broadly to the ocelli, and the outer more narrowly from near the top to the base of the mandibles, yellow; the face fuscous in the middle; the mandibles black, the palpi yellowish. The face punctured, thickly covered with long, fuscous hair; the inner orbits above the antennæ (the yellow part) are raised; the front is black, shining, and transversely striated; the vertex behind the ocelli and the occiput, except at the edges, brownish. Thorax brownish, mottled with black, a broad band on the pronotum, the tubercles, the scutellum, except at the apex, and the scutellar keels, lemon-yellow. The pronotum in the centre is black, shining, and roundly incised. On the mesonotum there are three broad, black lines, the middle one being the longer; the scutellar depression is black and shining. Scutellum punctured, more finely and closely on the apex; the postscutellum is smooth and shining; broadly depressed in the middle; its apex rounded. Median segment smooth and shining; its middle at the base broadly, triangularly depressed; its base ferruginous, the middle lemon-yellow, the apex black. Pleuræ smooth and shining; the lower part of the mesopleuræ roundly projecting. Mesosternum shagreened, thickly covered with fuscous hair; the central furrow blackish, closely transversely striated. The four anterior coxæ and trochanters and the tibiæ in front are more or less lemon-yellow; the basal half of the hinder

tibiæ and the hinder tarsi are infuscated; the hinder coxæ dark rufous, marked with black and with a yellow mark on the top behind; the basal joint of the hinder trochanters yellowish. Wings hyaline, with a distinct fulvous tinge, especially at the base; the cloud originates at the end of the stigma, becomes gradually narrowed, and reaches to the areolet; the pedicle of the latter is about two-thirds of the length of the basal branch of the transverse cubital nervure; the apical branch is bullated on the lower side; the recurrent nervure is received almost in the middle of the areolet, and is bullated above and below the middle. Abdomen for the greater part black; the petiole rufous to near the apex above; the apex black with a lemon-yellow band behind it; the second segment black, with a large lemon-yellow mark in in its middle; its base triangular, its apex transverse; these two segments are smooth, the others shagreened; the third, fourth, and fifth have lemon-yellow marks on the sides, these marks being gradually narrowed on the inner side; the apical segment is depressed, smooth and shining at the base, and is triangular in shape; the apical segments are thickly covered with fulvous hair.

LYTARMES HYALINIPENNIS, *sp. nov.*

Niger; facie, orbitis oculorum, scutello, postscutello, metanotoque flavis; pedibus rufis, coxis flavis; alis hyalinis, stigmate testaceo. ♂.

Long. 12 mm.

Scape of the antennæ and the base of the flagellum yellowish, the flagellum rufous, darker towards the apex, and thickly covered with short, stiff hair. Head lemon-yellow; the ocellar region and the middle of the front broadly black; the vertex behind the ocelli and the occiput, brownish; the front on the lower part obscurely

transversely striated. The oral region is ferruginous, the mandibles deep black; the palpi yellow; the face punctured; the clypeus smooth. Mesonotum dark brownish with two yellowish, longitudinal stripes; the scutellar depression and a somewhat triangular depression in front of it black. The scutellum, scutellar keels, and postscutellum lemon-yellow, the scutellum rather strongly punctured, thickly covered with long, white hair; the postscutellum smooth, glabrous; the apex of the scutellum brownish. The base and apex of the median segment and the spiracular region black, smooth and shining, sparsely covered with fuscous hair; in the middle at the base, is a depression longer than broad, which becomes narrower and shallower towards the apex. Pleuræ smooth and shining, covered with long, white hair; the upper half of the propleuræ lemon-yellow; the lower black, except on the lower edge, where it is yellowish testaceous. Mesopleuræ black; the tubercles and a large mark below them yellow; the lower edge rufous, the rufous band wider at the apex, where it is continued obliquely upwards to the middle. Metapleuræ yellowish, black round the base, the lower side, the apex and at the spiracles. Mesosternum rufous, black at the oblique base; strongly punctured, thickly covered with fuscous hair; the middle furrow transversely striated. The front legs fulvous; the coxæ and trochanters yellowish; the middle legs similarly coloured, except that the tarsi are blackish; the hinder legs rufous, their coxæ yellow, broadly marked with black inside and out; the basal joint of the trochanters yellow; the tibiæ and tarsi blackish, thickly covered with short, pale hair. Wings clear hyaline, the stigma testaceous, the nervures darker; the pedicle of the areolet is half the length of the basal abscissa of the cubital nervure, which is straight; the apical one is curved. Abdomen black; the base of

the petiole and a broad band down its middle, a long line down the middle of the second segment ; a narrow transverse one on its apex, the apices of the third, fourth, and fifth segments broadly yellow ; the apical segments obscure rufous ; the ventral segments, except the apical, testaceous.

EPHIALTES.

A. *Yellow marked with black.*

The Indian species belonging to this genus form two well marked sections.

1. Middle lobe of the mesonotum raised and distinctly separated from the lateral ; the median segment coarsely punctured ; in the middle at the base with a distinct depression ; the second and third abdominal segments with distinct transverse depressions, smooth.

EPHIALTES NIGRITARSIS, *sp. nov.*

Flavus, nigromaculatus ; metanoto punctato ; alis hyalinis, stigmate fusco, nervis nigris. ♂.

Long. 16 mm.

Antennæ nearly as long as the body, black ; the scape yellow, marked with black above ; the base of the flagellum brownish. Head smooth ; the face slightly punctured, shining ; the front broadly, the vertex at the top and the occiput, black. Mandibles black, yellowish at the base ; the palpi yellow ; the face slightly projects in the middle at the base, the projection being bordered by black. Thorax shining ; the middle lobe somewhat pear-shaped, raised above and clearly separated from the lateral ; it is broadly black in the middle ; the lateral lobes are broadly black down the middle, the black line somewhat abruptly narrowed beyond the middle and continued across the apex, there being also a broad central line. Scutellum and postscutellum, smooth and impunctate. Median

segment strongly punctured, except in the centre at the apex; in its middle at the base is a depression about twice as long as it is broad; the base being deeper than the apex, especially in the middle. The base of the propleuræ smooth, the apex obscurely punctured, the mesopleuræ obscurely punctured at the base, where it is broadly black from near the tubercles; the basal half of the sternum is black, the black broadly and roundly projecting at the sides; the furrow on the apex of the mesopleuræ is deep, narrow; the extreme apex is finely punctured on the upper side. Metapleuræ rather strongly punctured, except at the base above, where the punctuation is much finer; the basal depression is deep black; the keel between the coxæ is stout. Legs coloured like the thorax; thickly covered with long, white hair; the apex of the hinder coxæ, of the hinder tibiæ and the hinder tarsi entirely, black; the calcaria pale yellow. Wings hyaline; the base with a faint fulvous tinge; the costa and stigma dark fulvous beneath; the areolet broader than long; the second transverse cubital nervure is curved; the recurrent nervure is received in the apical fourth. Abdomen smooth, except the base of the second segment, which is punctured strongly in the middle; the third is more strongly punctured and striated in the middle; the sides rough; the other segments are smooth; the petiole is broadly depressed in the middle; the second depressed in the punctured part at the base; the second and third segments are depressed across the middle and obliquely at the sides; the third is broadly black at the base; the others black in the middle; the black mark rounded at the apex; the marks on the fifth and sixth segments are larger and broader than on the others.

2. Middle lobe of the mesonotum not raised, nor distinctly separated from the lateral; the median segment

smooth, impunctate, without a distinct depression at the base; the abdominal segments strongly punctured.

EPHIALTES NIGROMACULATUS, *sp. nov.*

Flavus; capite, thorace abdomineque nigromaculatis; antennis nigris, basi fuscis; trochanteribus posterioribus, basique tibiarum posticarum nigris; tarsis posticis fuscis; alis hyalinis, nervis stigmateque nigris. ♀.

Long. 13-14; terebra 13 mm.

Scape of the antennæ black; the apex yellow; closely punctured, sparsely covered with long, pale hair; the flagellum blackish, brownish at the base; thickly covered with stiff, microscopic pubescence. Head yellow; the vertex broadly in the centre, and diverging laterally above the ocelli to shortly down the occiput and across to near the edge, and a small mark on the face in the centre below the antennæ, black. Face obscurely punctured, covered with longish, pale hair; the clypeus almost smooth; at its base is a deep, transverse furrow; mandibles broadly black at the apices; the palpi pallid yellow. Mesonotum smooth, shining; a large black mark on each lobe; the apex of the scutellum, the postscutellum, and a curved mark on the apex of the median segment, black; the apical lobe of the propleuræ is for the greater part black; the black mark at the base on the upper side being roundly incised; at the apex transverse; below the middle on the apex of the mesopleuræ is a black mark, transverse at the apex, rounded at the apex. The upper part of the metapleuræ closely and strongly punctured, the lower quite smooth. Wings clear hyaline; the nervures and stigma deep black; the areolet oblique, above triangular; the recurrent nervure is received in the apical third of the cellule. Legs shining, stout, thickly covered with white hair; the apices of the four posterior trochanters and the

base of the hinder tibiæ black; the hinder tarsi dark fuscous. The basal depression of the petiole smooth; its sides and apex strongly punctured; the other segments are also strongly punctured, except the apical, which have the punctuation much weaker; on the petiole the black line is continuous; on the 2nd-5th segments there is a longer central, and a smaller lateral black mark; on the 6th and 7th there is only a central line; the cerci are black and covered with longish pale hair. The sheaths of the ovipositor are black and thickly covered with fuscous hair.

B. *Black, the four anterior legs yellow.*

EPHIALTIS TINCTIPENNIS, *sp. nov.*

Niger; pedibus posterioribus rufo-flavis; alis fere hyalinis, stigmate fusco; antennis fuscis. ♂.

Long. 19 mm.

Antennæ deep black; the flagellum bare; the scape on the lower side thickly covered with long, pale fuscous hair, and rather strongly punctured. Head deep black; the face and clypeus thickly covered with long, fuscous hair; the face strongly and uniformly punctured, thickly covered with long, pale fuscous hair; the orbits sharply margined, depressed. Clypeus smooth, the apex testaceous; the middle with a large semicircular depression. Mandibles black; the palpi testaceous. Front and vertex smooth, shining, sparsely covered with short, fuscous hair. The pro- and meso-thorax shining, smooth; the median segment strongly uniformly punctured, the punctures running into reticulations on the sides; the apex above with a semicircular smooth space. Scutellum with shallow, widely separated punctures and covered with long, pale fuscous hair; the postscutellum minutely punctured,

shining. Pro- and meso-pleuræ shining, smooth; the apices of both crenulated, the former indistinctly above; the meso- on the lower part at the base is bounded by a sharp, narrow keel which is continued across the sternum; this part is obscurely punctured and has, near the base, a crenulated furrow. The metapleuræ below the keel obscurely punctured and bounded, on the lower side, by a distinct keel. The four anterior legs are entirely fulvous, the hinder pair black, except the apical joint of the trochanters and the extreme base of the femora, which are rufous; the calcaria are pale testaceous. Wings hyaline, but with a slight fulvous tinge; the areolet triangular, the nervures uniting above; the recurrent nervure received in the basal fourth. Abdomen closely and strongly punctured; the basal depressions of the petiole smooth; its apex is more strongly punctured than the second segment.

THERONIA AREOLATA, *sp. nov.*

Fulva, brunneo-maculata; antennis brunneis; alis fulvo-hyalinis, stigmate fulvo, nervis nigris. ♀.

Long. 12; terebra 3 mm.

Antennæ as long as the body; the scape brownish, yellowish beneath, the sides with a black line; sparsely punctured and covered with long, pale hairs; the flagellum brownish, darker towards the apex. Head yellowish; the front in the middle and the occiput, except near the eyes, brownish. Face sparsely punctured in the middle, the clypeus smooth; mandibles yellowish, the teeth black; the palpi yellowish, more fulvous towards the apex. Thorax luteous, the mesonotum brownish, the sides and two lines down the middle, yellowish. Scutellum impunctate, thickly covered with long, black hairs; its sides and apex yellow; the depression at the base deep black. Postscutellum smooth, almost bare; at the base deeply bifoveate;

the lateral keels oblique, sharp; the central partition triangular. Median segment shining, impunctate; the central area pyriform; the keel bounding it broad and flat at the base, sharp at the apex, where it is deeply hollowed; the lateral basal areæ are large, wider than long, shallow; the apical deeper, shorter and narrowed obliquely on the inner side, the bounding keel being curved; from its apex two stout keels run obliquely, forming a somewhat triangular area. Pro- and meso-pleuræ smooth, shining; the metapleuræ also smooth; the keel below the spiracles sharp and narrow. Legs stout; the hinder coxæ and femora suffused with fulvous; the hinder tarsi rufous. Areolet oblique; the recurrent nervure is received in the apical fourth, about the distance of the length of its top. Abdomen brownish; the base and apex of the petiole broadly; the apices of the second and third segments broadly, and of the fourth and fifth narrowly, yellow; the petiole sharply carinated laterally to shortly beyond the middle; the base and the sides depressed obliquely beyond the middle.

THERONIA NIGROBALTEATA, *sp. nov.*

Fulva, nigro-maculata; alis hyalinis, apice fumatis; stigmate testaceo. ♀.

Long. 10; terebra 3 mm.

Comes near to *T. areolata*, but is smaller; has the thorax and abdomen marked with black, and otherwise may be known by the central area on the base of the median segment being square and not hollowed. Antennæ stout, brownish, darker towards the apex, the scape paler. Face punctured all over; fulvous, yellowish at the top; the clypeus impunctate; the mandibular teeth black. Mesonotum dark brown; the sides and two lines down the middle yellow; the scutellar depression, and a narrow

line at the tegulæ, black. Scutellum fulvous, yellow at the sides, the apex broadly black; the postscutellum yellow; its foveæ large. The base of the median segment black, the black narrow in the centre; at the sides broader and continued to the apex of the spiracles; the basal central area is almost square, flat; the single lateral one is longer than it is broad, narrowed at the apex; the keels bordering the central area are indistinct, the lateral more strongly defined. Pro- and meso-pleuræ smooth, shining, the apex of the propleuræ narrowly, the base of the mesonotum, a longitudinal line immediately under the tubercles, an oblique one extending from above the middle to near the apex, becoming wider as it does so, and ending forwards at right angles to the base of the coxæ, black. The four anterior legs are yellow, the femora and the middle tibiæ and tarsi tinged with fulvous; the hinder coxæ are broadly black at the base below and at the sides; the apical joint of the trochanters, the femora broadly in the middle, and the tibiæ, rufous; the tarsi dark fuscous. Wings hyaline; the apex infuscated; the areolet oblique, the nervures united at the top; the recurrent nervure received shortly beyond the middle. Abdomen rufous; the apices of the segments yellow; the petiole, the second and third segments black in the middle; the others broadly black at the apex; the depression at the base of the petiole shallow; the furrow down the apex deep; in the centre of the second segment at the base is a narrow, deep, longitudinal furrow; the oblique depression at the sides is deep.

THERONIA GRACILIS, *sp. nov.*

Long. 9; terebra 3 mm.

A smaller and more slender species than *T. nigrobalteata*, with which it agrees in having the abdominal

segments banded with black ; but it differs in having the central area on the base of the median segment open at the apex; the lateral area shorter and broader at the apex; the petiole longer compared with the second segment; the wings not infuscated at the apex; the areolet slightly larger and receiving the recurrent nervure in the middle.

Antennæ brownish, darker towards the apex; the scape yellowish beneath, and thickly covered with long, fuscous hair; the clypeus smooth; the apex slightly waved; mandibular teeth black. Mesonotum brownish; the sides and two lines down the middle, yellow ; the scutellar depression and a semicircular mark at its base, and the sides at the hinder wings, black. Scutellum not much raised; the sides above keeled; the base yellow, rufous in the middle; the apex black. Postscutellum rounded and narrowed at the base; the bordering keels stout, oblique. Median segment black at the base; the lateral areæ entirely black ; the spiracular are black in front of the spiracles. The apex of the propleuræ, the base of the mesopleuræ on the lower side, a band under the tubercles, an oblique one across the middle reaching to the apex of the middle coxæ, and a mark in front of it over the coxæ, black. The middle area on the base of the mesonotum with straight sides and open at the apex ; the apex straight, oblique. The four anterior femora are slightly, the hinder almost entirely, fulvous ; the hinder coxæ at the base on the outer side black, the hinder tarsi dark fuscous. Costa and stigma dark rufo-testaceous ; the nervures black ; the areolet oblique, receiving the recurrent nervure, if anything, before the middle. Abdomen : the sides of the petiole at the middle, a broad band shortly beyond the middle, a narrower band on the second, third, fourth and fifth segments in the middle, and the sixth and seventh segments at the base, black ; the furrow on the petiole is wide and

deep, as are also the depressions on the sides of the second; the furrow at its apex wide and deep; the central furrow at the base deep.

PIMPLA.

A. *Entirely ferruginous, wings fulvous.*

PIMPLA OLYNTHIA, *sp. nov.*

Ferruginea; flagello antennarum nigro; alis rufo-flavis, apice fumatis. ♀.

Long. 18; terebra 16 mm.

In coloration agrees with *P. nigricornis* Sm. (*Proc. Linn. Soc.*, IV., 65), but that is smaller and has the mesonotum punctured.

Uniformly rufo-ferruginous; the face, palpi, orbits and apices of the four anterior coxæ, pale yellow. Scape of antennæ rufo-ferruginous; the base of the flagellum dark rufous on the under side. The orbits and base of the mandibles and palpi pale yellow; the apex of the mandibles black. The thorax is more elongated and narrowed behind the tegulæ than usual. The coxæ and femora are covered with moderately long, white, the tibiæ and tarsi very thickly with shorter, more fulvous coloured, hairs; the claws are black. Wings yellowish hyaline; the apices of both with oblique smoky clouds, the costa, stigma and nervures yellowish; the areolet oblique; the recurrent nervure is received in the apical fourth of the cellule. Petiole smooth, impunctate the base oblique, the sides distinctly margined; the keel being continued to the centre of the apical portion, on the outer side of the middle; the space between being depressed; the second, third, and fourth segments are closely punctured down the middle, and on the transverse depressions; the fifth is broadly depressed at the base and more strongly and closely punctured; the sixth is closely and finely punctured; the apical almost

impunctate; the ventral segments, except the apical one, sulphur-yellow. Sheaths of the ovipositor covered thickly with pale, somewhat rufous, hair.

B. *Head and fore-legs ferruginous; the abdomen and hind-legs black; wings yellowish hyaline.*

PIMPLA ARIANA, *sp. nov.*

Nigra; capite, scapo antennarum, thorace pedibusque anterioribus ferrugineis; alis flavo-hyalinis, apice fuscis. ♀.

Long. 17; terebra 13 mm.

Antennæ black; the scape ferruginous, thickly covered with longish, black hair; the flagellum covered closely with a minute, almost microscopic, pile. Face and clypeus yellowish, suffused under the antennæ with ferruginous; smooth, impunctate; sparsely covered with long, fuscous hair; the apex of the clypeus obliquely depressed. Mandibles yellowish, the teeth black; the base shagreened; the apex smooth and shining; the palpi rufo-testaceous; thickly covered with longish, pale hair. Thorax shining, impunctate; the pleuræ sparsely, the median segment more thickly, covered with long, white hair. Legs thickly covered with long, white hair; the four anterior entirely rufo-ferruginous, except for the claws; the posterior black, the apical joints of the tarsi rufous beneath. Wings flavo-hyaline, obliquely infuscated from near the discoidal nervure across the areolet to the apex of the radial nervure, which it only touches at the apex. The costa and stigma rufo-ferruginous; the areolet oblique; the transverse cubital nervures almost unite at the top; the recurrent nervure is received quite near to the second transverse cubital. Abdomen black; the ventral surface, except at the apex, pale dirty testaceous; the petiole smooth; its apex broadly raised, the base of the raised

part depressed, with the sides raised; the other segments very coarsely and closely punctured; the second smooth at the base and the sides at the apex behind the depression, except for a row of punctures in the middle, the row bifurcating at the apex; all the segments, except the last, are equally widely depressed shortly beyond the middle; the apical segments are smooth and quite without punctures. The sheaths of the ovipositor densely and shortly pilose.

C. *Luteous species with black marks or lines on the thorax and abdomen.*

I. The abdomen with black transverse lines, besides the black marks.

a. The mesonotum for the greater part black, with two oblique yellow spots in the centre of the black part; the black marks on the third and fifth abdominal segments curved. *P. curvimaculata.*

b. The mesonotum luteous, with black marks; the abdominal lines straight.

The marks on the mesonotum small and forming almost a continuous line; wings fulvous, the apex not distinctly smoky, the stigma and nervures fuscous, the depression on the petiole indistinct. *P. appendicularis.*

The mesonotum in front with three large, black marks; wings hyaline, the apex distinctly smoky; the stigma and nervures black. *P. apicipennis.*

PIMPLA CURVIMACULATA, *sp. nov.*

Long. 15 mm. ♂.

The flagellum of antennæ black, brownish beneath; the scape yellow, black above; covered with longish, fulvous hair. Head yellow; the ocellar region black; the occiput above with a large, curved, fulvous mark; the mandibular teeth black, piceous at the base; the face strongly punctured, slightly dilated in the middle; sparsely

covered with short, white hair; the basal half of the clypeus closely punctured; the apex obliquely depressed, smooth; the front and vertex impunctate, smooth, shining. Thorax luteous; the mesonotum from shortly before the base of the tegulæ to the base of the scutellum black; in the middle are two oblique yellow marks, which are triangular at the base, rounded at the apex; at the base the black is slightly and roundly dilated at the sides. Scutellum pyramidal, the apex oblique; the leaf-like expansions on the sides large, thin. The keels bordering the lateral areæ stout; the areæ for the greater part black; the middle at the base distinctly depressed; across the middle of the segment is a curved keel, which is united at the sides to the keels of the basal areæ. Pleuræ very smooth, shining; the sternum punctured; at the apex of the mesosternum is a large leaf-like expansion, triangularly narrowed towards the apex, which, in the middle, is slightly and roundly incised. The middle keel on the metapleuræ well defined. Legs stout; the tarsal claws and the hinder knees black. Areolet small; the transverse cubital nervures united at the top, almost appendiculated. On the petiole there is a broad transverse mark, at the end of the depression; on the third segment is a fusco-black mark; the apex narrowed; the base curved on either side and ending on the lower side in a sharp point; on the fourth is a small black dot on either side; on the fifth is a similar mark to that on the third, but smaller; there is an elongated mark on the sides of the sixth; on the penultimate is a large, transverse mark. The petiole is impunctate; the base broadly depressed, the sides of the depression sharply carinate; on the apex in the middle, reaching to the transverse line is a conical depression; the other segments are closely and rather strongly punctured; the transverse depressions longitudinally striated.

PIMPLA APPENDICULARIS, *sp. nov.*

Flava; maculis parvis mesonoti, apiceque tibiarum posticarum nigris; alis fulvo-hyalinis, stigmate rufo-fusco, nervis fuscis. ♀.

Long. 15; terebra 5 mm.

Antennæ longer than the body, black; the scape yellow, the base of the flagellum brownish beneath at the base Head yellow, except the ocellar region, which is black. Face closely punctured; the clypeus smooth on the obliquely depressed apex, the base obscurely punctured Mesonotum closely punctured at the base; the raised central part at the base bordered by distinct furrows; at the base of the tegulæ there is a mark, broader than long, followed in the middle by a narrower and longer one, the whole forming an almost continuous line. The basal depression of the scutellum black; the keel to the middle large and leaf-like, on the apical half much smaller; the scutellum sparsely covered with long, black hair. Median segment smooth; the base between the keels narrowly black; the black continued along the inner side of the lateral keel, becoming gradually wider to the base behind, and slightly extending beyond the outer side of the keel; the middle keel broadly curved and united to the apex of the segment by a lateral one. Pleuræ smooth, shining. Legs coloured like the thorax; the basal joint of the hinder trochanters on the under side, a large mark on the under side of the hinder femora in the middle, the apex of the tibiæ and the apical two joints of the hinder tarsi, black. Wings with a distinct fulvous-smoky tinge; the costa rufo-testaceous; the stigma rufo-fuscous; the nervures fuscous. Areolet shortly, but distinctly, appendiculated, triangular; the recurrent nervure received in the apical third. The petiole broadly, but not deeply depressed at the base; its sides stoutly

carinate. The keels continued down the apical part to the raised middle of the apex ; the part between being depressed, broadly at the base, narrowly at the apex ; the second segment black at the base, the black bifurcating to the furrow at the sides ; there is a broad, continuous, transverse line on the centre of the third, a line about three times as long as it is broad on the sides of the fourth, a continuous line on the fifth, a short mark in the centre on either side of the sixth, and an almost complete one across the seventh segment, black ; the sheaths of the ovipositor black.

PIMPLA APICIPENNIS, *sp. nov.*

Fulva ; thorace abdomineque late nigromaculatis ; alis hyalinis, apice fumatis, stigmate nervisque nigris. ♀.

Long. 13 ; terebra 2 mm.

Antennæ as long as the body, the scape yellow, largely marked with black above ; sparsely covered with white hair ; the flagellum brownish at the base. Face closely punctured, thickly covered with short, pale hair ; the clypeus not quite so strongly punctured ; its depressed apex punctured like the base. The mandibles coloured like the face, with the teeth black ; the palpi similarly coloured and covered with long, white hair. The ocelli are in a black patch, the black extending beyond them all round. The middle lobe of the mesonotum bearing large punctures ; between the tegulæ are three large, black, marks ; the central almost square, the lateral dilated in the middle on the outer side into a point half its length. Scutellum pyramidal ; more obliquely depressed at the base than at the apex, where the slope is longer ; thickly covered with long, pale hair ; the sides stoutly keeled, the keels not leaf-like. On the base of the median segment is a black band, which extends to the lateral basal keels ;

in the centre at the base is a distinct fovea, slightly longer than it is wide, and triangular at the apex; the keels in the centre at the base are oblique; the apical prolongation slightly oblique and not so straight, and united to a keel at the end; the apex has an oblique slope and is stoutly keeled all round. All the pleuræ smooth and shining; below the tegulæ largely tuberculate; the centre of the mesopleuræ at the base roundly projecting; in the middle at the apex is a sharp, slightly oblique, short furrow; the metapleuræ at the top roundly projecting; the base behind the spiracles obscurely punctured; the central keel narrow, but distinct. Legs stout; the base of the hinder tibiæ, all the claws and the apices of the four hinder tarsi, black. Wings clear hyaline, except at the apices where there is a distinct, narrow, smoky cloud; the areolet small, triangular, distinctly appendiculate at the top; the recurrent nervure is received in the apical third. Petiole at the base smooth and shining; the apex obscurely punctured; the apical part at the base with a shallow depression in the middle, rounded at the apex; the oblique furrow at its apex not very clearly defined, obscurely striolate, the second and following segments coarsely punctured, running into obscure striations on the apices; the transverse furrows striolated. Shortly beyond the middle of the petiole is an interrupted black line, narrowed on the inner side; the line on the second is broad and entire; on the third there is none; on the fourth is a broad line, interrupted in the middle; on the sixth the black line is complete, and slightly narrowed in the middle at the apex; the sheaths of the ovipositor black.

II. *Abdomen with black marks, and with only a black transverse line on the penultimate.*

a. Abdomen with the third and following segments punctured.

To this section belongs *P. dedator* Fab.

The two new species here described may be separated as follows:—

The marks on the mesonotum extending to the base of the scutellum, the median segment distinctly areolated, without two black marks at the base; the wings smoky at the apex. *P. lepcha.*

The marks on the mesonotum only found on the base; the median segment not distinctly areolated, only the basal areæ being defined; and bearing two black marks at the base; the wings not smoky at the apex. *P. ceylonica.*

PIMPLA LEPCHA, *sp. nov.*

Long. 15: terebra 2 mm.

Very similar to *P. khasiana*; but may be known from it by the marks on the mesonotum being larger, by the abdomen being distinctly punctured, by the petiole being shorter compared with the second segment and having in its centre, as has also the second segment, a distinct depression; there are no black marks on the second segment; the basal central area on the median segment is distinctly wider than its length, and distinctly narrowed from the middle; and the apical lateral area is narrower compared with the basal. The scape of the antennæ yellow, black above; the flagellum black, brownish at the base. Head lemon-yellow; the vertex and occiput black, the black on the vertex narrowed between the eyes. Face strongly punctured, covered with longish, white hair; its sides near the eyes raised into a blunt, slightly curved keel. The apex of the clypeus transverse, slightly bare; mandibles yellow, the teeth black; the palpi yellow, covered with glistening white hair. Mesonotum shining, impunctate; in the

middle is a black mark, extending to the apex, much narrowed in the middle, where it extends from side to side and is united to a mark on the sides, which is broad at the base, becoming much narrowed at the base. Scutellum pyramidal, the sides stoutly keeled; the apex with a more gradual slope than the base, smooth, impunctate, sparsely covered with pale hair; the sides of the postscutellum carinate laterally; the depression at the base shorter and more abrupt than on the apex. Metanotum shining; the middle area at the base, clearly wider than it is long; the basal lateral area on the outer side almost twice the width of the inner side; the apical area shorter than it, slightly wider on the inner, distinctly narrower on the outer side than the basal one; the central keel larger than the others, especially on the outer side. Pleuræ smooth and impunctate; below the tegulæ there is a projection, or tubercle; immediately above the middle of the meso-pleuræ there is a stout, slightly oblique projection, which is flatter towards the apex. Wings hyaline; the stigma and nervures black; the apex of the fore-wings distinctly, of the posterior faintly, infuscated; the areolet triangular, very slightly appendiculated at the top; the re-current nervure is received very shortly beyond the middle. Legs stout, coloured like the thorax; a mark, longer than broad, and narrowed towards the apex on the hinder femora between the middle and the apex above; the base of the hinder tibiæ, the extreme base of the hinder tarsi and the apical two joints of the hinder tarsi, black. On the petiole, at the end of the keels, are two obscure dots; near the base of the third are two marks, rounded and dilated on the inner side at the base; on the fourth and fifth segments are somewhat large marks, broader than they are long; rounded on the outer side, transverse on the inner; the penultimate broadly black at the base; the

base slightly and roundly incised on the apex. The keels on the sides of the petiole are stout and reach to the middle, where there is an elongate shallow fovea followed by a shorter one; the transverse furrows on the second and fifth segments are distinct, and closely longitudinally striated; the third segment is slightly, the fourth and fifth segment more strongly, punctured; on the last segment, at the base of the oblique furrows, is a depression which is longer than it is broad.

PIMPLA CEYLONICA, *sp. nov.*

Long. 10 mm.

Hab. Trincomali, Ceylon (*Col. Yerbury*).

Scape of antennæ yellow, black above; the flagellum rufous, darker above. The ocellar region black; the black extending behind to the end of the vertex and to an equal distance in the middle beyond them at the apex. Face closely punctured, covered with short, silvery pubescence; the clypeus bluntly rounded at the apex; the mandibular teeth black. Thorax shining, impunctate; on the base of the mesonotum are three black marks, the lateral large, longer than it is broad; its sides at the base on the outer side obliquely truncated; the central mark smaller, its base slightly curved inwardly, the apex triangular. Scutellum rather flat; sparsely covered with pale hair, smooth; the sides narrowly keeled; the sides of the post-scutellum indistinctly keeled. Median segment very smooth; the central area fully twice as broad as long; the lateral areæ are slightly longer and rounded at the apex, wider on the outer than on the inner side, the black marks being inside of them. Legs stout; the hinder femora distinctly rufo-fulvous; the base of the hinder tibiæ black. Wings clear hyaline; the stigma and nervures black; the former testaceous at the base; the areolet

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distinctly appendiculated, triangular ; the apical transverse cubital nervure curved ; the recurrent nervure is received shortly beyond the middle. Petiole shining, impunctate, the base depressed ; the apex of the depression rounded ; its sides narrowly keeled ; the keels obliquely continued to shortly beyond the middle; the second segment is broadly depressed laterally at the base ; the transverse furrow wide. The third, fourth, and fifth segments are closely and rather strongly punctured ; the sixth obscurely punctured ; the apical smooth ; the transverse furrows are distinct, moderately wide and deep, and obscurely crenulated. On either side of the petiole in the middle are two irregular marks, wider than they are long : there are no marks on the second ; there are two large marks on the base of the third ; on the base of the fourth are two small marks ; on the base of the fifth two large marks broader than they are long; on the base of the penultimate are two larger marks.

b. Abdomen impunctate.

The central area on the median segment square, the basal two segments each with two black marks. *P. khasiana.*

The central area on the median segment wider than it is long, wider at the apex ~~base~~ than at the base ~~apex~~ ; the basal two segments immaculate. *P. indubia.*

PIMPLA INDUBIA, *sp. nov.*

Long. 15 mm.

Similar in coloration to *P. lepcha*, having only 6 marks on the abdomen ; but that differs in having the middle segments of the abdomen strongly and distinctly punctured, and in having the middle basal area of the median segment distinctly narrowed from the middle to the apex, whereas in the present species it becomes gradually

widened from the base to the apex, the apical bounding keel, too, having a distinct curve; the scutellum is more sharply pyramidal and, looked at from behind, is seen to be distinctly triangular; the lateral marks on the mesonotum do not reach to the apex. *P. khasiana* comes near to it also, but is longer, has more marks on the abdomen, has the central basal area ~~mark~~ on the median segment, as long as broad, whereas in *P. indubia* it is distinctly wider than it is long, and the alar nervures from the stigma are distinctly fuscous.

Antennæ longer than the body, black; the extreme apex rufous; the basal three joints yellow beneath. Head yellow; the occiput except at the sides, the ocellar region and the front in the middle, black; the black on the front gradually narrowed to a point at the apex, dilated at the base. The face closely punctured; the sides bluntly keeled to near the apex, which is only obscurely punctured; the clypeus smooth; the tips of the mandibles black. In the middle of the mesonotum is a cup-shaped black mark, the narrow basal part being as long as the dilated apical, which, at the base, is roundly incised; the lateral marks as long and as wide as the dilated part of the central; they are narrowed gradually to a point at the apex; the base on the inner side transverse; on the outer, obliquely truncated. Scutellum pyramidal, smooth; looked at from behind it is somewhat triangular, with the sides straight, smooth, impunctate, and covered rather thickly with long, fuscous hair; the keel on the lower side leaf-like, large. The keel on the sides of the postscutellum narrow. The central area and the base of the median segment distinctly broader than it is long; the lateral keels straight, slightly, but distinctly, diverging towards the apex; the apical keel slightly and gradually curved; the basal lateral keel large, not much wider on the

outer side; the apical oblique, considerably widened from the inner to the outer side. The mesopleural tubercles large, sharply projecting; the middle below them also projecting, but not so acutely. Wings hyaline, the areolet triangular above; the recurrent nervure is received in the middle. Legs coloured like the thorax; the femora with a more fulvous tinge; a mark on the upper side of the hinder femora near the apex, the extreme base of the hinder tibiæ, their apex narrowly, all the claws and the apical joint of the hinder tarsi, black. Abdomen shining, impunctate; a black mark on either side of the second, third and fourth segments, those on the second slightly smaller, more irregular and not so square, and a transverse band, narrowed in the middle at the apex, black; the sheaths of the ovipositor black.

PIMPLA KHASIANA, *sp. nov.*

Fulva; thorace late 3-maculato, abdomine 12-maculato, lineaque apicis nigromaculata; alis hyalinis, apice fumatis; nervis stigmateque nigris. ♀.

Long. 16; terebra 2 mm.

Antennæ black; the scape yellowish beneath; the base of the flagellum brownish. Head with the face thickly covered with white hair; the ocellar region and a wider mark, rounded above, in the centre of the front, black. Face coarsely punctured; the sides stoutly keeled near the eyes; the clypeus obscurely punctured; the depressed apex almost smooth. Mandibles obscurely punctured at the base, covered with white, intermixed with fulvous, hair; the teeth black, piceous behind; the palpi fulvous, covered with short hair. Mesonotum shining, impunctate; in the middle is a large, black mark, extending from near the base to the apex; its apex almost transverse, but slightly incised in the middle; beyond its middle the

mark becomes narrowed gradually but distinctly, then becomes dilated into a triangle, which at its apex, is slightly wider than the widest part of the basal portion; the lateral marks are slightly wider than the central; they are as long as the basal part of the central mark; slightly dilated in the middle on the outer side, and oblique at the apex. Scutellum pyramidal; the top with a short, transverse keel-like projection; the lateral keels large, leaf-like and of nearly equal height throughout. The postcutellum with the sides bluntly keeled. Median segment smooth; the central basal area almost square; from its centre and apex two stout keels run to the sides where they unite with a longitudinal keel, thus forming two lateral areæ on each side. Pleuræ very smooth and shining; on the metapleuræ is a curved keel in the middle. Legs stout, thickly covered with fulvous hair; on the apical third of the hind femora, on the inner side at the top, is a black mark, which is dilated below on the lower side; the base of the hinder tibiæ, the extreme base of the tarsi and their apical joint, black; the apices of the four anterior claws are black. Wings hyaline, the apices of both smoky; the nervures and stigma black; the areolet triangular, slightly appendiculated; the recurrent nervure is received almost in the middle. The first and second segments of the abdomen are smooth and shining; the keel on the sides of the petiole extends to the middle—to the base of the black dot; the transverse, curved furrow on the second segment is longitudinally striated; those on the other segments are also striated, but not so distinctly. The black marks on the petiole small, on the second segment slightly larger and dilated in the middle at the apex; on the third and fourth larger, on the fifth and sixth still larger, broader, being distinctly broader than they are long; on the sixth small and may be absent; the ~~sixth~~ has a wide,

transverse band, incised in the middle at the apex; the oblique furrows on the last segment, narrow, deep and distinct.

The following species is probably related to the foregoing group. The colour of the abdomen and legs is doubtful, as the ferruginous tint of the abdomen and legs may be caused by chemical discoloration; but structurally it is distinct from any of the yellow species. The scutellum is more distinctly keeled at the apex than in the yellow species, the apical and the lateral keels being continuous.

PIMPLA HONORATA, *sp. nov.*

Nigra; thorace sordide olivaceo; abdomine rufo, nigro-balteato; pedibus rufis; alis hyalinis, stigmate costaque nigris. ♀.

Long. 8; terebra 1 mm.

Antennæ nearly as long as the body, stout, not tapering much towards the apex, closely covered with short pubescence, dull rufous, darker towards the apex. Head smooth, shining, the face thickly covered with short, white hair; the clypeal foveæ deep, large; the mandibles black; the palpi pale dirty yellow. Thorax smooth and shining; the mesonotum and scutellum dull olive; the former with three large, almost united, marks between the tegulæ, keeled down the sides and round the apex; the scutellum, rounded from the base to the apex, not much raised above the mesonotum, but its apex considerably so above the postscutellum, which is depressed laterally at the base; the lateral depressions large. Median segment with a gradually rounded slope, impunctate, glabrous; at its base are two large areæ, one on either side; they are broader than they are long, and triangularly narrowed at the apex; from its centre a curved keel runs

to the apex of the segment, its apical part being thicker than the basal; before its middle, on the inner side, and joined to it, is a short, oblique keel. Pleuræ smooth and shining, glabrous; the metapleuræ with a curved keel above and below; the tubercles are distinct. Legs stout; the anterior olive-coloured, as are also the middle coxæ; the hinder knees are black, the tarsi are infuscated. Wings hyaline, the stigma blackish, the nervures paler; the areolet is shortly appendiculated; the recurrent nervure is received in the middle. The first, third, and fifth segments are broadly marked with black in or near the middle, the mark on the fifth being interrupted; the base of the petiole largely depressed; the inner side of the depression carinate, the keels being continued into the apical part to near the end of the segment; on the apical third is a transverse row of deep punctures; the second to fifth segments are closely punctured; the transverse depressions are longitudinally striated.

D. *Black, the abdomen brownish-testaceous; the legs yellowish and fulvous.*

PIMPLA BICARINATA, *sp. nov.*

Nigra; abdomine oreque brunneis; pedibus pallide flavis, femoribus posticis fulvis; alis hyalinis, nervis stigmateque nigris. ♀.

Long. 10; terebra 4 mm.

Antennæ black, the scape thickly covered with long, white hair. The face is shining, bluntly carinate in the middle (but not at the top and bottom), sparsely punctured and covered with longish fuscous hair. Clypeus, labrum and mandibles brownish, shining; the mandibular teeth black; the palpi pale yellow; the front and vertex shining, impunctate; the former not much depressed.

Thorax shining, impunctate; the mesonotum thickly covered with long white hair; the scutellum with a few shallow punctures; the postscutellum closely punctured; the median segment, except in the middle, strongly and uniformly punctured; the smooth, central space bordered by straight distinct keels which diverge slightly towards the apex. Pro- and meso-pleuræ smooth, shining, sparsely covered with longish, pale hair; the apex of the meso-pleuræ depressed; deepest at the extreme apex, which is crenulated on the lower part; the basal depression on the metapleuræ deep, not very broad; the part below the curved keel and the base entirely smooth; the upper part strongly punctured. All the coxæ and trochanters are yellow; the hinder femora, tibiæ and tarsi fulvous. Abdomen brownish; the petiole above in the middle to near the apex, and the apices of the second to fifth segments narrowly, black; the basal depression of the petiole, the sides near the middle, a broad, oblique band on either side at the apex, and the apex itself, smooth and impunctate; the other segments are strongly and closely punctured, the punctures becoming weaker towards the apex; the transverse depressions on the third and fourth segments are wide and deep. The basal ventral segment black; the others fulvo-testaceous. The sheaths of the ovipositor very hairy. Wings clear hyaline; the stigma and nervures black; the areolet oblique, elongate, shortly appendiculate; the first transverse cubital nervure oblique, straight, the second curved; the recurrent nervure received in front of it, almost touching it.

E. *Black; the abdomen banded with white; the four anterior legs yellow.*

PIMPLA CARINIFRONS, *sp. nov.*

Nigra; scutello, pedibus anterioribus basique tibiarum

posticarum late flavis; abdominis segmentis albolineatis; alis fusco-hyalinis, nervis stigmateque nigris. ♀.

Long. 15; terebra 3 mm.

Antennæ black; the scape covered with longish, pale hair; the flagellum densely with short, stiff, black hair. Head black, the palpi lemon-yellow; the face strongly punctured; the lower part of the face bluntly carinate, the raised part smooth in the centre; sparsely covered with soft, white hair; the base of the clypeus strongly punctured; the rest of it depressed, smooth. Front broadly, and rather deeply, depressed; the apex smooth and impunctate; the upper part obscurely shagreened; stoutly keeled down the centre; the inner orbits distinctly margined. The mandibles strongly punctured at the base. Thorax black; a large, yellow mark on the scutellum, rounded at the base, narrowed slightly towards the apex, which is slightly roundly incised. Mesonotum minutely punctured, thickly covered with short, fuscous hair. The basal slope of the scutellum has large, scattered, punctures; the apical slope is oblique and is strongly rugosely punctured. The base of the postscutellum is oblique; the centre is shining, obscurely striated; the depression at its side wide and deep, the bottom obscurely crenulated. Median segment broadly raised in the middle; the base smooth and shining in the middle; the centre beyond this strongly striated, the sides more closely and finely striated. Propleuræ strongly shagreened, towards the apex finely striated; the base of the mesopleuræ sharply keeled; behind this keel it is largely and obliquely raised; closely punctured, the top of the raised part at the base furrowed; the basal half behind this is punctured, but not strongly; the upper part at the apex smooth, the lower finely closely longitudinally striated; behind this it is strongly crenulated, the apex itself being smooth behind the

crenulation. Metapleuræ closely, longitudinally striated, the striæ on the apex stronger than on the base. The fore legs are bright lemon-yellow, except at the base of the coxæ; the middle lemon-yellow, except the coxæ and the base of the trochanters; the hinder legs black, except the basal half. Wings hyaline, the basal half suffused with fulvous; the stigma and nervures black. The base of the petiole is strongly punctured; the sides strongly aciculated; the other segments are closely and uniformly punctured; on the under side, in the middle at the base, the petiole has two straight, slightly diverging keels; its apex is finely transversely striated.

PIMPLA FLAVIPALPIS, *sp. nov.*

Nigra; linea pronoti, scutello, metanoto abdomineque albomaculatis; pedibus rufis, coxis anterioribus albis, nigro-maculatis, coxis posticis nigris, albomaculatis; alis hyalinis, stigmate nigro. ♂ *et* ♀.

Long. 7-11; terebra 2 mm.

Antennæ slender, black; the scape closely punctured, yellow beneath. Head shining; the front hollowed, shining, the middle bare, the sides bearing a short, white pubescence; the lower ocellus bordered with an irregularly crenulated furrow, from which a narrow, smooth one runs down to the antennæ. Face strongly and closely punctured, thickly covered with white hair; the face in the middle shining, smooth, slightly projecting. Mandibles at the base closely rugose; the palpi yellow. Thorax black; a narrow line on the pronotum, a mark on the scutellum and postscutellum and two elongated tubercle-like marks on the sides of the median segment, extending from the middle to the apex, and the tubercles, yellow. Mesonotum smooth and shining; the scutellum covered

with short, white hair; the middle punctured, but not strongly; the base of the scutellum has a wide oblique slope. Median segment closely transversely striated, the base and apex with the striations finer and closer than on the middle. Propleuræ smooth and shining in the middle; the base strongly aciculated; the apex coarsely longitudinally striated; the striæ much longer in the middle, extending triangularly backwards to the middle. Mesopleuræ closely punctured; running into striations near the tubercles; the apex coarsely crenulated. Metapleuræ coarsely punctured above; the apex coarsely striated; the part below the furrow closely and somewhat obliquely striated. The four anterior coxæ are black; largely yellow at the sides and in front; the hinder coxæ black, except for an oval mark in the middle behind; the trochanters black at the base; the anterior yellowish at the apex; the anterior femora, tibiæ and tarsi fulvous, the tarsi with a more yellowish hue; the middle femora, tibiæ and tarsi rufous; the hinder femora rufous, black at the apex; the hinder tibiæ and tarsi black; the tibiæ with a whitish-yellow band near the base. Wings hyaline; the base with a slight fuscous tinge; the stigma and nervures black; the areolet oblique, slightly appendiculated; the recurrent nervure is received in its apical third. Abdomen closely punctured, very slightly only on the base of the petiole and on the apical segment; on the apices of the first, second and third segments are yellow marks; that on the first triangular, on the second and third longer, and narrowed on the inner side, the fourth has a complete band, widened at the sides, the others have large marks laterally, all narrowed to a point on the inner side; the ventral segments are broadly banded with pale yellow.

The ♂ has the four anterior legs of a more yellowish hue, the coxæ being entirely yellow and without any

black; the white marks on the abdominal segments are larger laterally and continued across the sides.

In size it is variable. One ♀ is only 7 mm. in length. The males also vary in length. The extent of the white on the abdomen varies; in some females there is only white on the sides; in others the white is continued right across, especially on the middle segments.

G. *Body black, the legs rufous.*

PIMPLA POESIA, *sp. nov.*

Nigra; tegulis scutelloque flavis; pedibus rufis; coxis, trochanteribus tarsisque posticis nigris; alis fulvo-hyalinis, stigmate fusco-fulvis. ♀.

Long. 16; terebra 5 mm.

Scape of antennæ distinctly, but not closely, punctured, sparsely covered with long, white hair; the flagellum almost bare. Face strongly and uniformly punctured. The basal part of the clypeus with scattered punctures except at its apex; the apical part of the clypeus smooth, depressed, the apex slightly shagreened; the hairs on it are sparse and longer than those on the face. Mandibles sparsely punctured and covered with dark hairs. The basal joints of the palpi blackish; the apical dark testaceous. Vertex broadly, but not deeply, depressed; the sides minutely punctured; the centre with a narrow, shallow furrow, and closely and finely transversely striated. Mesonotum strongly and uniformly punctured. Scutellum yellow, except round the edges; sparsely covered with large, not very deep, punctures, which are more widely separated in the middle; the depressed apex almost rugosely punctured; the postscutellum not so closely nor so strongly punctured as the apex of the scutellum.

Median segment transversely rugosely punctured; much more strongly at the base than at the apex; the centre at the base bears a slightly raised, bordered fovea, about three times as long as broad and rounded at the apex. The base of the propleuræ raised in the middle, finely rugose at the base, running into fine striations. Mesopleuræ strongly punctured, sparsely covered with a dark, microscopic pile; the lower two-thirds of the base is obliquely depressed, this depression having at the apex a clearly defined, curved border; the apex very smooth and shining, and having in front a stoutly crenulated border. The basal part of the metapleuræ closely, the apical rugosely punctured, and running into reticulations; the depression at the top behind the spiracles rugosely punctured at the apex; the apex shining, smooth, except for some stout keels near the middle. All the coxæ and trochanters are black; the hinder tarsi are black; their basal joint on the under side thickly covered with stiff, longish, dark fulvous pubescence. Wings fulvo-hyaline, the fulvous tinge not so conspicuous at the apex; the stigma fulvo-testaceous; the nervures blackish; the cubital nervure at the base and the first transverse cubital nervure pale fuscous; the areolet narrowed at the top, oblique; the transverse cubital nervures are almost united at the top; the recurrent nervure is received in the apical third. The apices of the abdominal segments are narrowly obscure testaceous; the depression on the petiole is smooth and shining; the sides coarsely and closely punctured; the middle with the punctures slightly smaller and more widely separated; the extreme apex smooth; the second to fifth segments closely and strongly punctured, but the punctuation becomes gradually weaker; the sixth segment aciculated; the apical smooth. The tegulæ are pale dirty testaceous in front, black behind.

PIMPLA HIMALAYENSIS, *sp. nov.*

Nigra; pedibus flavis; coxis femoribusque posticis rufis; tibiis posticis nigris, medio late albis; tarsis posticis fuscis; alis hyalinis, stigmate nervisque nigris. ♂.

Long. 12 mm.

Head shining, smooth; the front roundly and broadly projecting in the middle, at the top bearing some rather large punctures; the sides and bottom almost impunctate; sparsely covered with fuscous hair; short above, much longer below; the base of the clypeus is minutely punctured; the palpi pale yellow; mandibles shining, smooth, black. Front and vertex shining, impunctate; the depression on the front is deep, and does not extend backwards to the ocelli. The upper part of the thorax thickly covered with fuscous hair; the hair on the scutellum longer, on the median segment still longer and paler; smooth, impunctate, as is also the post-scutellum. Except in the centre at the base the median segment is strongly punctured; the punctures large, deep; the base smooth, the punctures in the middle not so strong as on the apex, where they almost form reticulations; at the base in the middle is a smooth area, twice as long as broad, the apex transverse; the sides bordered by a straight stout keel, interrupted in the middle; the apex is open, being bounded only by the punctures. Propleuræ smooth, and very shining, deeply hollowed below; the apex at the top punctured; the sides crenulated from top to bottom; the mesopleuræ smooth and shining; the furrow near the base curved, moderately wide and deep, not reaching to the tubercles; at the tegulæ strongly punctured, the punctured space somewhat triangular; the apex depressed below, and bordered by a narrow crenulated furrow. Metapleuræ strongly punctured, the portion below the keel with the

punctures weaker than on the upper part ; the base above rugose ; bordered by a row of punctures. Wings hyaline ; the stigma and nervures black ; the transverse cubital nervures are united at the top of the areolet ; the recurrent nervure is received in its apical third. The four anterior legs are yellow; the femora with a fulvous tinge ; the hinder tibiæ are white ; near their base is a narrow black line, and there is one, twice its length, on the apex ; the hinder femora and coxæ are fulvous ; the tarsi blackish. Petiole rugosely punctured throughout ; depressed at the base ; the sides to beyond the middle stoutly keeled ; the other segments closely punctured ; the basal strongly punctured ; the punctuation on the others becomes gradually weaker. The basal ventral segment is keeled to shortly beyond the middle ; the apex smooth ; the depressed sides above aciculated, the lower part finely obliquely striated ; the outer edge of the segment is longitudinally striated ; the other ventral segments black.

PIMPLA INDRA, *sp. nov.*

Nigra ; femoribus tibiisque anticis rufis ; alis fulvo-hyalinis, stigmate nervisque nigris. ♀.

Long. 15 ; terebra 5 mm.

Antennæ black ; the scape smooth, shining ; the flagellum almost bare. The face strongly punctured ; the clypeus with a row of larger, deeper and longer punctures ; the front smooth ; broadly depressed ; the lower part quite smooth, the upper obscurely transversely striated in the middle. Mesonotum shining, having a faint plumbeous hue. Scutellum at the base very shining, bearing only a few slight punctures ; its apex rugosely punctured. Post-scutellum smooth, the depression at its sides wide, strongly longitudinally striolated. The basal two-thirds

of the median segment strongly transversely striated, most strongly so in the middle; the apex in the middle smooth, slightly raised in the middle; the sides obscurely aciculated. The base of the propleuræ finely longitudinally striated; the lower two-thirds of the apical part rather strongly longitudinally striated. Mesopleuræ coarsely punctured, the middle smooth above; the apex stoutly crenulated; the part over the middle coxæ coarsely striated. Metapleuræ coarsely rugosely punctured; the apex more closely punctured than the base; the basal depression smooth in the middle, the sides roughly punctured. Legs black; all the femora and the anterior tibiæ ferruginous; the anterior tarsi fuscous. The central depression on the petiole smooth; the sides and apex roughly aciculated; the sides at the apex divided by a flat, oblique, raised part; in the centre above it is finely transversely striated, intermixed with large punctures.

PIMPLA VIDUA, *sp. nov.*

Nigra; femoribus, tibiis tarsisque anterioribus femoribusque posticis rufis; tibiarum posticarum basi late albo-annulato; alis hyalinis, nervis stigmateque nigris. ♂.

Long. 8 mm.

Antennæ black, the flagellum covered with a white down; the scape closely punctured, covered with longish, pale hairs. Face and clypeus thickly covered with long, white hair; the front and vertex shining, impunctate, almost glabrous; the maxillary palpi are white; the labial fuscous. Mesonotum shining, obscurely punctured, as is also the scutellum; but the sides below the latter are strongly punctured. Median segment coarsely, rugosely punctured, except the base and the apex in the middle; thickly covered with longish, fuscous hair. The lower

part of the propleuræ behind strongly longitudinally striated; the mesopleuræ obscurely punctured, covered with longish, soft, white hair; the metapleuræ coarsely punctured, more closely and coarsely on the lower part. All the coxæ are black, and thickly covered with white hair; the trochanters are black at the base; the hinder tibiæ and tarsi black, thickly covered with white hair; near the base of the tibiæ is a white band, which extends to shortly beyond the middle; the calcaria are white. Abdomen entirely black; closely and coarsely punctured; the posterior segments with the puncturing weaker, and densely covered with long, white pubescence. The transverse cubital nervures nearly unite at the top; the recurrent nervure is received near the apical third of the cellule.

PIMPLA LATIFOVEATA, *sp. nov.*

Nigra; facie, tegulis pedibusque flavis; femoribus posticis rufis; abdomine rufomaculato; alis hyalinis, stigmate fusco. ♂.

Long. 9 mm.

Flagellum of antennæ black, slightly brownish beneath towards the apex, covered with a microscopic pile; the scape yellow, black above; and there is a narrow, black line down the sides; sparsely covered with long, white hair. The face, clypeus, palpi and the mandibles, except at the base, yellow; the face bearing large, scattered punctures and sparsely covered with short fuscous hair; the front and vertex smooth and shining, the frontal depression shallow. Thorax smooth and shining except the median segment. The apex of the scutellum and the postscutellum brownish; the median segment except in the middle, at the base and the apex, covered with shallow, widely separated punctures; the middle at the base smooth, and bordered laterally by narrow, slightly diverging keels.

Pleuræ shining, impunctate; except the meta- above the keel; the keel near the base of the mesopleuræ distinct; the furrow in front of the apex is crenulated; behind, at the edge, brownish. The upper part of the metapleuræ sparsely punctured; immediately over the spiracles is a semicircular, shallow depression. Legs stramineous; the hinder coxæ slightly, the hinder femora distinctly, fulvous. Wings hyaline; the nervures blackish; the stigma fuscous; the areolet elongate, three times as long as its height; the transverse cubital nervures united at the top; the recurrent nervure is interstitial. Abdomen black, the ventral surface white; the base of the second and third segments narrowly red, the red continued obliquely down the sides to unite with a broad band on the apex; the third segment similarly coloured, but darker at the apex; the fourth rufous at the base only; the petiole smooth at the base; the triangular depression moderately deep, and continued down the middle to the base of the punctured part as a wide, deep furrow, rounded at the apex; its sides and apex above, beyond the furrow, bearing large, deep punctures; the other segments strongly punctured; the punctures become closer and rougher; the apices of the second, third and fourth segments are impunctate.

This species, in the coloration of the legs, agrees with *P. himalayensis*, with which it also agrees in having two longitudinal keels on the base of the median segment; but it differs from it in the punctuation on the median segment being very much less strong and the punctures fewer in number; the punctuation on the abdomen is also weaker, and it differs in the form of the petiole, in which the apical furrow, so distinctly defined in the present species, is represented in *P. himalayensis* by a mere shallow depression; lastly, they are easily separated by the form of the areolet, and by *P. himalayensis* having the hinder tibiæ black and white, and the hinder tibiæ fuscous.

PIMPLA LAETIVENTRIS, *sp. nov.*

Nigra; pedibus rufis, coxis trochanteribusque flavis; abdomine flavolineato; alis hyalinis, stigmate nervisque testaceis. ♀.

Long. 10; terabra 8—9 mm.

Head shining; the front and vertex impunctate; the hinder ocelli bordered by a furrow on the outer side; the face thickly covered with pale hair; the clypeus depressed, thickly covered with long, fuscous hair; dull brownish, the apex black; the palpi stramineous; the mandibles black. Thorax black, except for a narrow line on the apical half of the pronotum and the tegulæ, which are yellow. Mesonotum shining, covered with short, black hair; the scutellum flat, aciculated, sparsely marked with punctures, and with a small round fovea in the middle, near the base; the postscutellum smooth, shining. Median segment strongly and uniformly punctured, except in the middle at the base and apex, where it is smooth, impunctate, and thickly covered with long, pale hair. Pro- and meso-pleuræ smooth and shining; the middle of the mesopleuræ sparsely haired; the upper part of the meta-pleuræ closely punctured; the part below the curved keel impunctate. Mesosternum smooth, thickly covered with pale hair. The four anterior legs have the red on the femora suffused with yellow; the hinder tibiæ and tarsi are paler, more yellowish in tint than the femora. Wings hyaline; the costa, stigma and nervures testaceous; the nervures paler, not so reddish in tint; the areolet slightly oblique, rather long; the transverse cubital nervures meet at the top; the recurrent nervure is received in the apical fourth of the areolet. Abdomen black; the sides of the third and fourth segments narrowly and obscurely, of the fifth and sixth more broadly and clearly, yellow; the sixth and seventh segments are bounded with lemon-yellow at

their apices. All the segments are closely and strongly punctured.

Comes near to *P. latifoveata*, which may readily be separated from it by the median segment being only sparsely punctured, by the smaller areolet, by the absence of a yellow line on the pronotum, and by the scutellum being more distinctly raised and less strongly punctured.

H. *Body and legs entirely black.*

PIMPLA EREBUS, *sp. nov.*

Nigra; tibiis tarsisque anticis flavotestaceis; alis hyalinis, basi fere fulvis; stigmate nervisque nigris. ♀.

Long. 13; terebra 4 mm.

Face closely punctured, thickly covered with short, white hair; below the antennæ the depression is large, triangular and deep; the centre is distinctly keeled; there is a distinct, semicircular depression at the base of the clypeus, the apex of which is obliquely depressed, smooth and shining; the front in the middle is stoutly, transversely striolated. Mesonotum almost opaque, thickly covered with short, depressed hair; the base transversely striated. Scutellum raised, smooth, and shining, sparsely covered with long, white hairs; the postscutellum with large, deep punctures; the depression at its sides wide and deep, and bearing large longitudinal striations. The base of the median segment is finely, transversely striated; the rest, to shortly beyond the middle, strongly transversely striated, the striations being thicker in the middle; the apex is broadly smooth; the sides striated. The propleuræ at the base finely longitudinally aciculated; the lower part strongly, the apical above more finely longitudinally striated; the central hollow strongly striated in the middle, smooth at the top and bottom. Mesopleuræ

strongly punctured; the apex smooth above, the lower side strongly longitudinally striated, the striations longest in the middle; the apex itself stoutly crenulated. Coxæ faintly punctured, and covered sparsely with white hair; the middle knees are testaceous. The basal depression on the petiole smooth and shining; the sides coarsely, but not very distinctly, punctured; the apex above with shallow punctures which are more numerous at the apex; the second segment is obscurely punctured; the others are very finely and closely transversely striated.

CHRYSOPIMPLA *gen. nov.*

Wings with the areolet petiolate, oblique, triangular, receiving the recurrent nervure before the middle; the apical abscissa of the radius roundly curved upwards at the base; the cubital nervure at the base straight, oblique, the part before the cubitus not curved or rounded, and except where the first recurrent nervures join it, almost on the same plane with the basal portion; the transverse median nervure is received before the transverse basal in the cubital-discoidal cellule. In the hind-wings the transverse anal nervure is interstitial. Head narrow, not dilated behind; the face elongated, largely developed below the eyes; the clypeus separated from the face by a narrow suture; the apex of the mandibles bidentate; the upper tooth the larger. Eyes distinctly converging on the lower side and distant from the base of the mandibles. Antennæ long and slender. Mesonotum shining, distinctly but not closely punctured. Scutellum large, convex, distinctly raised above the level of the mesonotum, its base with a long, rounded slope; its apex with a shorter oblique one; the postscutellum large, obliquely sloped at the base, not foveate there. Median segment without keels; and having a gradually rounded

slope from the base to the apex. The lineal spiracles are placed in the middle, if anything nearer the apex than the base. Legs, especially the hinder, stout; the base of the front tarsi incised, and nearly twice the length of the tibiæ; the fourth joint of the hinder tarsi minute, not half the length of the third; the claws large, curved. Abdomen closely punctured, except on the petiole, which is as long as the second segment, and is not much depressed at the base; the apical segment and the ovipositor as in *Pimpla*. The body black, largely marked with yellow; the wings with an apical cloud. Tarsi spinose.

In the elongated face, and in the form of the areolet and of the radial nervure, this genus resembles the Australian *Lissopimpla* Kriech. (*Xenopimpla* Cam.), but that differs in having the mesonotum trilobate, the median segment transversely striated and toothed laterally, the abdomen smooth, and the hinder femora toothed near the apex.

CHRYSOPIMPLA ORNATIPES, *sp. nov.*

Nigra; capite, thorace abdomineque late flavomaculatis; pedibus fulvis, coxis flavomaculatis; alis hyalinis, apice fusco-unimaculatis, stigmate testaceo. ♀.

Long. 14; terebra 5 mm.

Antennæ fully longer than the body; filiform, black, the scape yellow beneath, covered with pale hair; the base of the flagellum brownish beneath; the apex rufous. Head yellow; the front broadly in the middle, but narrowed before the ocelli; the ocellar region and the occiput, except near the eyes, black. The mandibles are yellow, with the teeth black; the palpi yellow. The entire head smooth, shining and impunctate; very sparsely covered with pale hair. Mesonotum black, closely and rather strongly punctured; on either side is a yellow line

running from the base to the scutellum; the base of the marks being somewhat triangularly dilated. Scutellum and postscutellum yellow; the scutellum raised, sparsely punctured; the depression at the base of the former deep, smooth; the postscutellum smooth. The median segment yellow, a large, black, hourglass-shaped mark down its centre; the basal part being longer and wider than the apical; the basal half of the segment is strongly, somewhat rugosely, punctured; above and touching the stigma is a black mark which reaches the base of the segment, becoming narrowed as it does so. Legs rufo-fulvous; the fore coxæ and trochanters entirely, the middle coxæ yellow, marked with rufo-fulvous behind; the hind coxæ black, yellow above, except for a large black mark in the middle, extending from the base to the apex, becoming gradually wider as it does so; the hinder tarsi infuscated. Wings clear hyaline, except for a large fusco-violaceous mark at the apex, extending almost equally on both sides of the apex of the radial nervure; the areolet is distinctly petiolated; slightly oblique; the recurrent nervure is received very shortly beyond the middle of the cellule. Abdomen black; closely and strongly punctured; the apices of the first to the fifth segments banded with yellow; the sixth yellow at the sides only, the middle of it being rufous; the last two segments are entirely rufous, narrowly lined with yellow at the apices; the ventral segments, except the apical, yellowish.

The ♂ is similar to the ♀ in coloration, except that the hinder femora are of a clearer yellow colour, and broadly marked with black; the hinder tarsi are blackish; the antennæ are as long as the body, the flagellum more brownish, and with the joints dilated at their apices; the black mark on the median segment is narrowed in the

middle, dilated at the base and apex, the basal dilation being the larger; the yellow on the mesopleuræ is more extended, the basal part being entirely yellow, as is also the sternum; the yellow lines on the abdomen are also more extended.

CHRYSOPIMPLA PERSIMILIS, *sp. nov.*

Long. 9 mm. ♂.

This species looks like a small form of the preceding *(P. ornatipes)*, with which it agrees closely in general coloration; but it is, I believe, quite distinct. Apart from the size, it differs in having the thorax quite smooth, without any punctures; the areolet is not petiolated; the abdominal depressions are very indistinct; the hinder coxæ not black marked with yellow, but yellow and fulvous marked with black above and at the side.

Antennæ slightly longer than the body; the scape yellow; the base and apex of the flagellum more or less brownish. Head shining, impunctate; the front broadly, the ocellar region, the vertex and occiput, except at the sides, black. Mandibular teeth black. Thorax shining, impunctate, except behind the metathoracic spiracles, where it is rough and irregularly punctured, and the extreme apex of the mesopleuræ, which is crenulated. On the mesonotum are two lines, dilated at the base, narrowed towards the apex, running from the base to the scutellum; the scutellum, postscutellum, the base of the propleuræ, a large mark on the mesopleuræ, broad at the base and continued narrowly there to the sternum, and irregularly rounded behind, and the metapleuræ, except the base and a line running obliquely to the spiracles, yellow. The median segment is yellow, except for a broad, hourglass-shaped mark, down the centre. Legs fulvous; the four front coxæ and trochanters, and

the hinder, except the base broadly behind, inside and out, and a mark, gradually dilated from the base to the apex in the middle, black; the hinder tarsi fuscous. Wings hyaline except for a fuscous violaceous cloud in the apex of the radial and the top of the cubital cellules; the areolet oblique; the transverse cubital nervures unite at the top, but do not form a petiole; the recurrent nervure is received shortly before the middle of the cellule. The petiole is smooth and shining, impunctate; the apex broadly yellow; the black at the apex and sides running into rufous; the other segments are closely and rather strongly punctured, except on the yellow apices; the depressions are not very strongly impressed; the apical segments entirely fulvous rufous; the ventral surface yellowish.

CTENOPIMPLA, *gen. nov.*

Areolet small, obliquely triangular, open at the apical margin; pedunculated, the pedicle as long as the cellule; the recurrent nervure is received near the apex. Head transverse in front; the clypeus separated from the face by a deep furrow; roundly projecting, its apex rounded. Mandibles bidentate at the apex. Eyes large, parallel, not curved at the top on the inner side, distinctly distant from the base of the mandibles. Parapsidal furrows obsolete; the median segment with a transverse keel near the apex. Legs more slender than usual; the claws pectinated. Abdominal segments longer than broad, shagreened. Ovipositor elongate, not originating from a ventral cleft. Metathoracic spiracles small, oval, placed at the apex of the basal third; the petiolar spiracles slightly smaller and rounder, and placed near the apex of the basal third.

The affinities of this genus are clearly with *Lissonota*,

from which it differs in the strongly pectinated claws; in the appendiculated areolet, in the longer and thinner legs, and in the basal three abdominal segments being longer compared with their breadth.

Some species of *Lissonota* have the areolet petiolate, but only shortly so. The hinder tarsi are spinose, the fore tarsi are twice the length of the tibiæ. The antennæ are longer—if anything longer than the body—than in *Lissonota*; the mandibular teeth are equal in length; the eyes are margined on the lower side; the transverse median nervure is received close to the transverse basal, nearer the apex of the wings.

CTENOPIMPLA ALBOMACULATA, *sp. nov.*

Nigra; facie, ore, linea pronoti, scutelli apice, linea magna mesopleurarum flavis; pedibus rufis; coxis trochanteribusque anticis flavis; coxis, trochanteribus, tibiis tarsisque posticis nigris; alis fulvohyalinis, stigmate nervisque fuscis. ♀.

Long. 10; terebra fere 10 mm.

Antennæ filiform, black; brownish towards the apex; the head below the antennæ lemon-yellow, except for a broad band down the middle of the face and the foveæ; the upper orbits narrowly yellow, and the outer orbits at the bottom more broadly, yellow. The front, vertex and the face closely punctured, sparsely pilose; the clypeus roundly convex, smooth, impunctate; the mandibular teeth black. Mesonotum opaque, closely punctured; the scutellum more strongly punctured; on the base are two large, yellow marks, somewhat pear-shaped; placed obliquely and meeting in the middle of the scutellum, where they almost unite; the notum at their sides shining and strongly striated. Median segment closely and uniformly punctured, except at the

apex, which is, in front of the keel, more strongly punctured. The mark on the edge of the pronotum is dilated at the base; the lower part of the propleuræ is more widely yellow, the band being dilated in the middle above; on the mesopleuræ in the middle is a broad, yellow band, curved upwards at the base and, to a less extent, downwards at the apex; on the metapleuræ, near the apex, is an irregular mark. The anterior coxæ and trochanters are yellow; the middle pair fulvous, tinged with yellow; the four anterior trochanters are marked with black; the hinder coxæ black, yellow at the base above; the trochanters at the base and the apex above, and the tibiæ and tarsi, black. Wings hyaline, tinged with fulvous, especially at the base; the costa and nervures fuscous; the petiole of the areolet is longer than its inner branch; the outer branch is obliterated beneath. All the abdominal segments are twice as long as broad; the petiole is longer than the second segment; the basal three segments are closely punctured, the apical quite smooth. Except at the apex, the ventral surface is lemon-yellow.

MEYVA, *gen. nov.*

Areolet with a long pedicle; the recurrent nervure interstitial with its second branch. Eyes large, reaching near to, but not touching, the base of the mandibles and not converging beneath. Mandibles with two stout, unequal teeth on the apex. Head oblique, not projecting behind the eyes; the occiput margined, Mesonotum forming one piece. Metanotum with a transverse keel beyond the middle; its spiracles elliptical; about three times as long as their breadth. Abdominal segments all longer than wide, the petiole as wide at the base as at the apex; its spiracles small, round, and placed at the end of the basal

third. Legs slender; the hinder tarsi not perceptibly longer than the tibiæ; tarsi spined; their claws simple.

The relationship of this to the genus *Ctenopimpla* here described is clear enough. The differences between the two may be expressed as follows.

Clypeus not separated, metapleural spiracles elliptical; the tarsal claws simple. *Meyva.*

Clypeus separated; metapleural spiracles small, oval, almost round; the tarsal claws pectinated. *Ctenopimpla.*

MEYVA VILLOSA, *sp. nov.*

Nigra, abdominis apice late pedibusque rufis; coxis, trochanteribus tarsisque posterioribus nigris; alis fusco-hyalinis, apice fumatis, stigmate nervisque nigris. ♂.

Long. 15 mm.

Antennæ black; the apex broken off. Head black; the inner orbits narrowly in the middle, more broadly and longer at the top and bottom, the outer narrowly, the clypeus, a transverse line above it, the mandibles broadly at the base, and the palpi, yellowish; the palpi more testaceous in tint. Face closely punctured, thickly covered with white pubescence; the front smooth, the vertex coarsely aciculated. Thorax thickly covered with short, pale hair, which is shorter and darker on the mesonotum, longer and paler on the metanotum. Mesonotum shining, strongly punctured; the scutellum also strongly punctured; the punctures larger and more widely separated than on the mesonotum; at the base of the scutellar keels is a yellow spot. Metanotum strongly punctured, the punctures deep, large and close to each other; above the apex is a stout, transverse keel. Pro- and meso-pleuræ closely punctured, the latter smooth and shining in the middle behind; the metapleuræ more closely punctured. The pedicle of the areolet is as long

as the cellule itself; its outer nervure is largely bullated beneath; the recurrent nervure is joined to it. The coxæ and trochanters are black; the anterior pair yellowish in front; the hinder tarsi are spinose beneath. Abdomen rufous; the petiole except at the apex; and an interrupted mark near the base of the second segment, black.

Macrogaster.

I believe I have correctly referred the following species to Brullé's genus *Macrogaster* (*Hymén.* iv. p. 185 pl. 41 f. 4), the type, and only known species, of which is from the Cape of Good Hope. His generic description, however, is very defective in some important points; and it is quite possible that our species may not belong really to *Macrogaster.* He places *Macrogaster* next to *Cryptus*, but the relationship of our species is undoubtedly with the *Pimplides.* In neuration it agrees with *Epirhyssa*, to which the species described by Smith (*Proc. Linn. Soc. Zool.* 1857, p. 121) is clearly congeneric; but it differs in the mesonotum not being striated, and in other respects. The following are the salient generic characters of our species.*

Head large, not much dilated behind the eyes, which are large, but do not reach to the base of the mandibles. Face keeled in the middle; clypeus rounded or with the sides slightly oblique at the apex; at the base not clearly separated from the face. Mandibles with a large lower, and a smaller upper, apical tooth. Antennæ stout or slender, but not so slender as in *Pimpla* or *Rhyssa.* Thorax stout; the mesonotum trilobate, the middle lobe

*This genus has the alar neuration of *Hemigaster*, but in other respects is very dissimilar, *e.g.*, that genus has not the mesonotum trilobate; the spiracles are received between the apex and the middle of the petiole; the basal three segments of the abdomen are greatly enlarged, the head is smaller, and the petiole bicarinate above.

small, triangular, transverse at the base; strongly punctured. Scutellum not much raised, its sides not carinate; its base depressed; the postscutellum bifoveate at the base. Median segment more or less areolated; its spiracles large, linear. Legs stout, as in *Pimpla*; the calcaria short; the claws long, curved, simple. Wings without an areolet; the transverse cubital nervure interstitial with the recurrent; the transverse basal nervure also interstitial; the first recurrent nervure is received in the basal third of the cellule, much nearer the base than in *Pimpla*. Abdomen stout; the petiole not so stout as in *Pimpla* and of variable form; the spiracles are placed shortly before the middle; the segments smooth and shining, neither punctured nor striated, and without depressions; the hypopygium large, cultriform; ovipositor elongate.

The genus as here defined falls into two groups.

a. Middle lobe of the mesonotum distinctly raised above the lateral ones; the median segment distinctly transversely striated or reticulated.

1. Body black.

   Legs entirely black; the antennæ not annulated with white. *M. nigricans.*

   Legs for the greater part fulvous and yellow; the antennæ annulated with white. *M. varipes.*

2. Body and legs rufuous; the hinder legs black. *M. ferrugineus.*

b. Middle lobe of the mesonotum not distinctly raised above the lateral ones, the median segment not distinctly reticulated or striated. *M. luteus.*

MACROGASTER NIGRICANS, *sp. nov.*

Niger; orbitis oculorum antice albis; alis hyalinis, apice fumatis. ♀.

Long. 13; terebra 12 mm.

Scape of antennæ above covered with short, blackish pubescence, below with longer, fuscous hair; the flagellum thickly with minute, stiff pubescence. Head black; the inner orbits from the antennæ to the base of the mandibles broadly, the upper third narrowly, yellowish testaceous. Face strongly punctured, running into irregular reticulations; projecting in the middle below the antennæ; the apex of the clypeus impunctate, the sides straight, oblique. The basal half of the mandibles above and below with large, deep punctures; the middle with two stout keels; covered with longish, white hair; the palpi fuscous. Mesonotum strongly punctured, the punctures large, deep; the base transverse, the middle lobe forming a large triangular piece raised above the rest, especially at the base. Scutellum shining, the apex with a plumbeous hue; the punctures large, deep, more widely separated; the fovea at the base large, deep, as wide as the base of the scutellum; in the middle are three stout keels; the middle one straight, the outer slightly thinner and more oblique. Postscutellum flat, large, having a small fovea in the centre at the base, and a large deep one, on either side, reaching near to the apex. Median segment at the base with a small area wider than long and with its apex roundly bent inwardly in the middle; the apex flat; stoutly transversely striolated; the sides at the base irregularly reticulated, irregularly margined at the apex; the sides irregularly reticulated in front of the spiracles. The base and apex of the propleuræ closely punctured; the middle depressed; the central depression at the top somewhat obliquely, the rest stoutly longitudinally, striolated. Mesopleuræ closely punctured above and at the base; the lower part more strongly punctured, almost running into oblique striations in the middle; the apex crenulated; the middle very smooth, shining, and of a

plumbeous hue; the metapleuræ at the top near the base, finely, the rest more coarsely, reticulated; closely covered with soft, white hair. Legs entirely black, except the fore femora and tibiæ in front, which are dirty testaceous, that on the femora having a more reddish hue; thickly covered with white hair; the coxæ and femora (especially the hinder) punctured rather strongly. Wings fusco-hyaline, a darker cloud below the stigma; the apex infuscated. Abdomen smooth, shining, having a distinct plumbeous hue; the basal segments glabrous; the apical fringed with white hair; the ventral segments plumbeous, their apices white; the hypopygium ploughshare-shaped, punctured.

MACROGASTER VARIPES, *sp. nov.*

Niger; flagello antennarum late alboannulato; pedibus anterioribus pallide flavis; posticis fulvis, nigromaculatis; alis hyalinis, fusco-bifasciatis. ♀.

Long. 12; terebra 13 mm.

Antennæ thickly covered with white hair, the under side of the scape, and second joint beneath, and the twelfth and following joints white. The face, except a large, squarish mark in the centre over the clypeus and a narrow black line running from the antennæ to it, the clypeus, the inner orbits from the ocelli, the outer narrowly above, broadly below, to the base of the clypeus, yellowish white. Face and clypeus strongly punctured, sparsely covered with white hair. Mandibles black; the base coarsely irregularly punctured, sparsely covered with long, white hair; the palpi whitish testaceous. Middle lobe of the mesonotum distinctly raised and separated from the lateral, not narrowed to a distinct point at the apex; the depression uniting it to the scutellar foveæ is bordered on either side by stout keels, and has at its base a few stout, somewhat curved, transverse keels; rather strongly, but

not deeply punctured, the middle of the lateral lobes and the apex in the middle almost smooth. Scutellum more strongly punctured than the mesonotum; the punctures larger and deeper. The base of the postscutellum deeply depressed, the depression divided in two by a narrow keel; the apex white, smooth, slightly and narrowly depressed in the middle. The base of the median segment smooth; the middle area almost square; the central space at the apex with a few stout transverse keels at the sides; the base of this part is transverse, its sides oblique; the part in front of the spiracles stoutly irregularly keeled; this space being divided into two by a stout, oblique keel. The top and base of the propleuræ closely, and not very strongly, punctured; the middle stoutly transversely below and obliquely striated above; the part behind the striated part at top being smooth. Mesopleuræ closely punctured; more closely and finely above than below; the middle smooth and plumbeous. Metapleuræ closely and coarsely punctured, the lower and posterior portions with the punctures running into reticulations. Wings almost hyaline, a cloud running from the stigma to the costal nervure and the apex fuscous; the recurrent nervure is received shortly behind the transverse cubital. The four anterior legs are yellowish, the femora having a more fulvous hue; the hind coxæ, except for an elongated white mark on the apex behind, the apical joint of the trochanters, the base of the femora narrowly, the apex broadly, and the apex of the tibiæ, black; the femora distinctly fulvous; the tibiæ fulvous towards the apex. Abdomen with a plumbeous hue; all the segments whitish yellow at the apex; the petiole more broadly than the others; the petiole longish; the basal half distinctly narrowed; the base on the under side with a distinct, sharp, slightly curved tooth. The

ventral surface from the petiole whitish yellow; the hypopygium also yellowish, narrowly lined with black down the middle.

MACROGASTER FERRUGINEUS, *sp. nov.*

Ferrugineus; flagello antennarum pedibusque posticis nigris; alis hyalinis, apice fumatis. ♂.

Long. 9 mm.

Antennæ nearly as long as the body, the scape clear, the base of the flagellum rufous; the scape sparsely covered with long, fuscous, the flagellum more densely with short, black hair. Head yellow, except the front broadly in the middle, the vertex and the upper part of the occiput which are black; the face strongly punctured, thickly covered with pale, fuscous hair, its lower part stoutly keeled in the middle; the clypeus broadly depressed in the middle, its apex smooth. Mandibles black, smooth, yellow, its apex black; the palpi pale yellow, thickly covered with long, white hair. The inner orbits are raised between the base of the antennæ and the lower ocellus; above they are bordered by a deep and wide furrow; the vertex is covered with large, deep, clearly separated punctures; the front is aciculated, sharply keeled down the middle; the keel extending to below the antennæ and bifurcated at the top. Mesonotum closely punctured; the depression at the apex of the middle lobe with four stout, longitudinal keels; there is a shallow, narrow furrow down the middle of the lateral lobes. The scutellum punctured all over, but not quite so strongly as the mesonotum; its apex, and the postscutellum have a yellowish tinge; the latter is smooth; the depression at its side closely striated at the base; its apex distinctly keeled. The median segment has three basal areæ, the central being much the smaller; the outer are sparsely

punctured; the middle beyond these is broadly smooth; the sides stoutly irregularly transversely striated; at the sides of the apex is a stout somewhat **Y**-shaped keel, the outer fork of which is larger and more curved, the tail of the **Y** being continued down to the lower side of the petiole. Propleuræ punctured above, the lower part smooth, the middle coarsely striated. The middle and upper part of the mesopleuræ smooth, except for some fine keels behind the tubercles, where they are depressed; the lower part obscurely punctured and covered with long, white hairs; the tubercles are large; the furrow at the apex bears some stout keels. Metapleuræ closely punctured, more closely at the base, where there is an oblique keel, which unites with the outer corner of the spiracular area; the latter is triangular at the apex, at the base its keels are oblique. Wings hyaline, except for the apical cloud; the nervures and stigma black; the transverse basal and the recurrent nervures interstitial; the latter has two large bullæ, its centre being thus completely separated from the lower and upper portions. The four anterior legs are rufo-testaceous; the hinder pair entirely deep black, and covered thickly with black hair; their calcaria are rufo-testaceous. Abdomen smooth, rufous; the apex more or less blackish.

MACROGASTER LUTEUS, *sp. nov.*

Luteus, nigromaculatus; antennis nigris; alis hyalinis, nervis stigmateque nigris. ♂.

Long. 8-9 mm.

Antennæ black, becoming brownish towards the apex; the under side of the scape clear, of the base of the flagellum obscure, yellow; the scape thickly covered with long, the flagellum much more thickly with shorter, fuscous hair. Face strongly punctured, thickly covered with short, fuscous hair; the middle above broadly carinate;

the clipeus semicircular above, slightly depressed, sparsely punctured, foveate at the sides above; its apex transverse, rounded at the sides. The inner orbits above distinctly margined; at the top of the eyes there is a distinct furrow; between the antennæ is a rounded keel; the front is depressed in the middle; the sides are closely punctured; the vertex sparsely punctured, black; the ocellar region being also black and, behind, the black extends on to the upper part of the occiput. Mesonotum strongly punctured; on the apex of the middle lobe is a large black mark, gradually narrowed and rounded to the apex; its base trilobate, the middle lobe the smaller; the lateral lobes are broadly black from near the base and are united at the apex at the scutellum. Scutellum with a rounded slope at the base and apex; strongly punctured, covered with long, fuscous hair; its apex bears a large black mark, rounded at the base. Postscutellum impunctate, shining, almost glabrous. The base of the median segment is black in the three basal areæ which are punctured, smooth at the base; the middle area is broader than its length, and rounded at the apex; from its sides runs a short, oblique keel; from the middle a shorter, straight one, and outside the oblique keels is a shorter one, also oblique; the apex is very smooth, its sides keeled, with a short, elongated area joined to it on the inner side at the top; inside this, near the base, is a short curved, transverse keel. Propleuræ strongly punctured, except in the middle, the lower side strongly obliquely striolated. Mesopleuræ strongly and closely punctured, except on the apical half near to the apex; the apex itself is raised and closely punctured; on the middle, at the apex, is an oblong black mark. Metapleuræ closely punctured, between the two keels bordering the spiracular region stoutly irregularly striolated. Mesosternum closely punctured, and thickly covered with pale

fulvous hair. Wings hyaline, except for a fusco-hyaline cloud in the apex of the wings; the recurrent nervure is received on the outer side of the transverse cubital, and is largely bullated above and below the middle; the transverse basal nervure is received distinctly behind the transverse basal. Legs coloured like the body; a small round mark on the outer side of the hinder coxæ at the top, the apical joint of the hinder trochanters and the hinder tarsi, black; the tibiæ and tarsi are thickly covered with short, fulvous hair; the posterior femora are strongly and closely punctured. Abdomen shining, impunctate; the base of the second and of the following segments black, the marks becoming narrower towards the apex; the gastrocœli are wide, smooth and oblique.

The amount of black on the legs varies; the hinder femora may be broadly black below.

HEMIGASTER CARINIFRONS, *sp. nov.*

Rufus; flagello antennarum, femoribus posticis, tibiis posticis late basique coxarum anteriorum nigris; annulo antennarum tarsisque posticis albis; alis hyalinis, stigmate fulvo.

Long, 8 mm.

Antennæ as long as the body, slightly thickened towards the apex; the basal two joints and the base of the third rufous; the seventh to the eleventh joints clear white; the basal joints of the flagellum elongate. Head rufous, except the mandibular teeth, which are black; the face and clypeus closely punctured, thickly covered with white hair; the clypeus not separated by a suture from the face, foveate at the sides above; the face stoutly carinate in the middle, the keel depressed at the base and the apex; the apex of the clypeus transverse, its sides oblique. The mandibles at

the base closely punctured, their sides keeled. Vertex closely punctured; the front smooth, hollowed; down its middle is a stout, sharp keel, obliquely bent on its lower side; on either side of it at the base is a short, oblique keel; the upper orbits, close to the eyes, are raised and sharply keeled, as is also the occiput on the lower side, and the latter, shortly above the mandibles, ends in a stout, oblique, somewhat triangular tooth. Mesonotum closely punctured; the parapsidal furrows narrow but distinct. Scutellum raised, longer than broad, narrowed towards the apex; closely punctured, thickly covered with fuscous hair; its sides and apex stoutly carinate; postscutellum keeled at the sides; behind it becomes gradually wider from top to bottom, and bears there some stout keels. Median segment smooth in the middle, the sides closely punctured, the outer and apical parts striolated; the basal area has an oblique slope towards the thorax; is keeled all round and obliquely narrowed towards the apex; from it run two keels to the apex, where they slightly converge; at the top they have a slight rounded, curved slope; at the base there are two lateral areæ, which are wider than their length; in front of this is an area of about the same size, with the outer side angled in the middle; the apical area is twice as long as wide. The spiracular area is large, deeply obliquely depressed at the base, wider than long, and separated from the anterior by a stout oblique keel; all the areæ found in the *Ichneumonides* are clearly defined. The central areæ are smooth, the apical thickly covered with short, white hair; the lateral spine is large, leaf-like, transverse. Propleuræ closely punctured; the lower side stoutly obliquely striated. Mesopleuræ closely punctured, except in the middle behind; above obscurely striated; on the lower edge is a deep, curved, crenulated furrow;

metapleuræ shagreened; over the hinder coxæ is a curved keel; the spiracles are linear, oblique, narrow, rounded at the base and apex. The mesopleuræ furrowed down the middle; the furrow stoutly crenulated, broadly black, on either side. Legs longish; the four anterior rufo-testaceous, their coxæ broadly black at the base in front; the terminal joint of their tarsi black; the hinder coxæ, trochanters, and base of the femora rufous, the rest of the femora black; the apical third of the tibiæ and the hinder tarsi, except the apical joint which is black, yellowish white; the tibiæ thickly covered with short, stiff hair; the hinder calcaria reach shortly beyond the middle of the metatarsus, which is spinose; the fourth joint is half the size of the third; the claws curved, simple. Petiole narrowed at the base, the apex dilated and curved; keeled down the sides and down the middle of the dilated part. Gastrocœli obsolete. The basal three segments large, of nearly uniform length; the others much shorter, and becoming gradually shorter. The base of the petiole is smooth, the apex closely punctured; the other segments closely punctured and thickly covered with short, white hair; the spiracles are small, oval, and are placed near the base of the apical third; the lower side is stoutly keeled along the edge. Wings clear hyaline; the stigma fulvo-testaceous; the nervures darker; there is only one transverse cubital nervure, and consequently no areolet; the transverse basal nervure is interstitial; the cubital nervure is oblique at the base and emits a short branch from its middle.

The ♂ does not differ much from the ♀ in coloration. The hinder femora are testaceous below, and the white colour on the hinder tibiæ and the tarsi is of a more reddish testaceous tinge, and the stigma is darker.

This species agrees fairly well with the description

given by Brullé (*Hymén.* IV., p. 266), and with his figure (*pl.* 41, *f.* 1) of *Hemigaster*, of which he describes a species from India and another from Australia, if he has not made a mistake about the latter, for he describes it as a *Hemiteles*, which is probably a slip of the pen. In some respects the genus is intermediate, judging by the species here described, between the *Ichneumonides* and the *Cryptides.*

The generic characters of our species may be represented as follows. Antennæ longish, thickened towards the apex. Eyes large, margined, front widely and deeply depressed, tricarinate in the middle, the inner orbits on the lower side stoutly keeled; face distinctly keeled down the middle, mandibles bidentate at the apex. Parapsidal furrows distinct, scutellum stoutly keeled. Median segment completely areolated. Spiracles large, linear. Areolet absent; radial cellule large, wide, the apical half broadly lanceolate. The basal three segments of the abdomen large, the others small; the petiole bent at the apex; the spiracles small, round, placed at the base of the apical third; the gastrocœli obsolete. Tarsi spinose, the claws simple.

The following new genera and species are described here somewhat out of their natural order pending the completion of the examination of the groups to which they belong.

ILEANTA, *gen. nov.*

Belongs to Wesmael tribe of the *Ichneumones*, and is most nearly related to *Ichneumon*, from which it differs, as it does from all other *Ichneumonidæ*, in the basal joint of the hinder tarsi having, on the lower side, a flattened leaf-like expansion extending from the base to near the apex,

it becoming gradually larger as it does so; the apex itself being broadly rounded. Antennæ flattened and dilated beyond the middle as in *Joppa;* mandibles at the apex with two large teeth. Scutellum flat; a broad, curved, deep depression at its base; its sides keeled. Median segment without closed areæ, only the posterior median being defined, and it is open at the apex; there are no spines. Metathoracic spiracles linear, longish, slightly curved, and placed near the base. Legs as in *Ichneumon* except as regards the metatarsus; the claws simple. Wings and gastrocœli as *Ichneumon.*

If it were not for the extraordinary structure of the metatarsus this genus might be included in *Ichneumon;* but the hinder tarsi are shaped quite differently from anything known among the *Ichneumonidae.* For anything like its form we have to go to the saw-fly genus *Croesus.*

ILEANTA LATITARSIS, *sp. nov.*

Nigra; annulo antennarum late, facie, orbitis oculorum, thorace abdomineque albomaculatis; pedibus rufis; coxis, dimidio apicali femorum posticarum tarsisque posticis nigris; alis hyalinis, stigmate nigro. ♀.

Long. 17 mm.

Antennæ black; the apex of the scape slightly and joints 9-20 white beneath; the apex attenuated; the part between it and the white-marked joints dilated and compressed; the scape punctured. Head black; the face and clypeus, the base of the mandibles broadly, the eye orbits all round, narrowly at the top, broadly at the bottom beneath on the outer side, white. Face and clypeus with shallow punctures; the middle of the face slightly projecting; the lower part of the sides of the projection marked with black, the black line curving anteriorly to the foveæ over the sides of the clypeus. The

teeth of the mandibles black; the part behind them piceous; the palpi white. Thorax black; the pronotum broadly in front, a line on its sides, a broad line over the mesopleuræ; the scutellar keels broadly, a narrow line on the apex of the scutellum, the postscutellum, two oblique lines on the apex of the median segment, not reaching quite to the apex itself, two marks on the apex of the first to fourth abdominal segments and the apical segments entirely, yellowish white. The upper part of the propleuræ finely and closely punctured; mesonotum closely punctured; beyond the middle (but not the apex itself) with the punctures larger and deeper. Scutellum, except in the middle at the base, with large, deep punctures; the postscutellum smooth; the median segment with large, deep punctures, which run into reticulations; the supramedian area is not very clearly defined, if anything, cordiform, raised and aciculated in the centre; the posterior median area narrow, longer than broad, rounded at the base, open at the apex; the other areæ not defined, but there is a keel on either side of the spiracles and two down the apex in the centre; the apex is oblique, its middle strongly transversely striolated, the sides more strongly and more obliquely striolated. Mesopleuræ punctured, except in the middle behind; the base coarsely irregularly striolated; the apex with short, stout, widely separated keels; the metapleuræ strongly irregularly reticulated and punctured, the part over the coxæ obliquely striated. The four anterior coxæ and trochanters yellow, the femora, tibiæ and base of tarsi fulvous, the hinder coxæ black, the trochanters fulvous and yellow, the basal half of the femora rufous, the apical black; the base of the hinder femora and the hinder tarsi, black. Areolet narrowed at the top, the transverse cubital nervures there being almost united; the recurrent nervure is received

almost in the middle. Petiole obscurely punctured at the apex, the base broad, and there is a broad mark on either side of the petiole; the second segment closely punctured, broadly and strongly striolated down the middle; the second more weakly striolated, the striæ not reaching to the apex; the fourth segment obscurely striated at the base. The yellow marks on the second segment are narrowed in the middle on the inner side; those on the third are slightly dilated on the lower side; those on the fourth are narrower and also attenuated on the inner side. The three basal ventral segments are yellowish testaceous, with a broad, black mark on the sides. Sheaths of the ovipositor black, their apex obliquely truncated, not rounded.

ROTHNEYIA ANNULICORNIS, *sp. nov.*

Nigra; annulo antennarum albo; tibiis tarsisque anterioribus brunneis; alis fusco-hyalinis, nervis stigmateque nigris. ♀.

Long. 8 mm.; terebra fere 2 mm.

Hab. Khasia.

This distinct species may be separated from *R. wroughtoni* (*Manch. Memoirs*, xli. (1897), No. 4, p. 19), as follows :—

Antennæ entirely black, 25-jointed, petiole ferruginous; the flagellum of the antennæ without a white band; the third abdominal segment toothed laterally. *R. wroughtoni.*

Antennæ 23-jointed, annulated with white; abdomen entirely black; the apex of the abdomen not toothed laterally. *R. annulicornis.*

Antennæ stout, slightly thickened from the middle towards the apex, bare; the sixth to the tenth joints white beneath; the second joint not much longer than

the scape and not much shorter than the preceding. Face strongly and closely punctured, thickly covered with short, pale hair; the clypeus more shining and with the punctures fewer in number and much more widely separated. Mandibles broadly piceous in the middle; the palpi testaceous, blackish at the base. Mesonotum closely punctured, more slightly at the sides. Scutellum strongly longitudinally punctured, narrowed considerably towards the apex, the sides stoutly keeled; the part underneath these lateral keels bearing stout, distinctly separated keels, the lateral keels at the apex projecting and having an oblique slope. Postscutellum not defined. Median segment large, flat at the base; the apex with a slightly oblique slope; the base of the segment smooth; the supramedian area broader than long, slightly dilated towards the apex; the posterior median at the top obliquely, at the middle and apex strongly, transversely striated. The spiracular area stoutly obliquely striolated, and having at its apex a large stout tooth, the base of which is stoutly striolated; the apex testaceous, smooth. Propleuræ finely punctured, the apex and lower side stoutly striolated. Mesopleuræ shining, the top finely punctured; at the base is a distinct keel, curved at the top below the tegulæ and having on its hinder edge below some stout striations; the apex of the mesopleuræ is crenulated, and the sternum is separated from the pleuræ by a deep depression at the base bordered on its lower side by a stout keel. Metapleuræ, except at the top towards the base, stoutly striolated, the upper half much more closely and regularly, and separated by a keel from the lower, which projects. Legs black; the anterior inclining to piceous or brownish; the femora pruinose. Wings smoky, more hyaline towards the apex; the stigma and nervures black; the areolet is narrowed at the top, being there about the length of the space bounded

by the recurrent and the first transverse cubital nervures; the cubital nervure in front of the areolet, the second transverse cubital and the recurrent nervures are largely bullated. Petiole shining, closely strongly and regularly striolated, and with a stronger striolation down the sides at the base, and extending to near the middle of the apical part; the second and third segments form one piece, the line of demarcation being only faintly indicated at the sides, and are uniformly and closely longitudinally reticulated and striated; the apex of the third rounded at the sides, which have no teeth, the centre looked at from above is transverse.

This species is very different from *R. wroughtoni*, differing markedly in some structural points; *e.g.*, the latter has on each side of the scutellum a stout triangular tooth; the second and third abdominal segments are distinctly separated; the third ends in a stout tooth at the sides. In *R. annulicornis* the third segment has a distinct well defined depression along the sides and apex.

Rothneyia and the new genus, *Chreusa*, here described, will form a new division of the *Ichneumones*, *Rothneyinæ*, distinguished by having only the basal three segments of the abdomen very large, the others being very much abbreviated, by the wings having no areolet, by the parapsidal furrows being obsolete, and by the petiolar spiracles being placed between the middle and the apex.

CHREUSA, *gen. nov.*

Belongs to the section of the *Ichneumonides* with the metathoracic spiracles linear, and with the spiracles on the petiole placed between the middle and the apex; but differs from them all in the three basal segments of the abdomen being large and of equal length; the third with the apex raised; the other segments minute, hidden under

the third; there is no areolet in the fore wings; the scutellum is large, pyramidal, broadly keeled laterally; the median area has only the basal or middle areæ defined, and is laterally armed with large teeth or with a plate. Eyes large, widely distant from the base of the mandibles; behind them, at the top, the orbits are hardly developed and they are distinctly margined next to the eyes. Antennæ dilated and compressed towards the apex. Clypeus not distinctly separated from the face; foveate on the sides at the base; its apex rounded. Mandibles triangular, with only one apical tooth. Thorax large, with indistinct parapsidal furrows, the mesopleuræ with a longitudinal furrow on the lower side. Abdominal petiole large, its apical half dilated; there are no gastrocœli. The last ventral segment is large; the ovipositor originates from its base. The base of the basal joint of the fore tarsi is largely curved, almost incised; the long spur of the tibiæ is curved.

The form of the abdomen—in having only three dorsal segments visible—resembles that of *Rothneyia*, but in other respects it is very different from that genus.

CHREUSA FULVIPES, *sp. nov.*

Nigra; annulo flagelli antennarum, facie, clypeo, palpis, tegulis, scutello, postscutello, metanoto, basi petioli abdominisque apice late, flavis; pedibus fulvis; coxis posticis nigris; alis hyalinis, stigmate nervisque nigris. ♀.

Long. 10; terebra 2 mm.

Antennæ as long as the body, black, the scape beneath and the 8-16th joints whitish yellow; the dilated apex brownish. Head slightly wider than the thorax, narrow; black; the part below the antennæ, the inner orbits—broadly below, narrowly above—pale yellow; the middle of the clypeus with a black mark. The face and clypeus

strongly punctured, sparsely covered with white hair; the vertex strongly punctured; the front deeply excavated. Thorax closely and strongly punctured, and thickly covered with white hair. The scutellum is black, broadly white round the sides and apex in front; behind entirely white, as is also the postscutellum; the scutellum is rugose and thickly covered with long, glistening white hair; its apex, looked at from the front, is rounded; its sides are strongly striolated; there is no depression at its base, nor are there any parapsidal furrows. The median segment is obliquely depressed at the base; the rest has a rounded slope; at the base in the centre there is a short, broad area, with curved, obliquely narrowed sides; from its sides two keels run to the apex of the segment. The entire segment is thickly covered with long, white hair, and is rugosely punctured; the lateral spines are large, broadly dilated laterally, and have a round fovea on the top; on the outside a keel runs from the spine to the apex; the part below them is pale yellow and is closely transversely striated. The base of the propleuræ is bright fulvous-yellow; the upper part is coarsely punctured; the lower part stoutly longitudinally striated. The mesopleuræ coarsely punctured; its base with a belt of fine punctures, the apex with a crenulated furrow; there is an oblique furrow in the middle, and there is a wider, deeper one on the lower side, marked with keels; the metapleuræ rugosely punctured; their base depressed; above at the base there is a band which is finely punctured. Mesosternum strongly punctured, deeply furrowed down the middle. The radial cellule is lanceolate at the base and apex; the transverse basal nervure is interstitial; the only transverse cubital nervure is curved; the recurrent nervure is largely bullated in the middle, and is received

on the outer side of the transverse cubital. The four anterior coxæ are pale yellow, black behind and on the sides above; the trochanters are pallid yellow; the hinder coxæ entirely black, strongly punctured, and thickly covered with white hair. The petiole is as long as the second segment; the basal half, the sides and apex pale yellow; it is, on the apical half, strongly and closely punctured, and thickly covered with white hair; down the middle are two stout, longitudinal keels and, outside these, is a shorter and more slender one; the sides and apex of the second segment—the yellow on the apex not extending to the sides—and the sides of the third and its apex widely, pale yellow; the second and third segments are closely punctured; the sides below acutely margined; below they are pallid yellow.

CHREUSA LUTEA, *sp. nov.*

Ferruginea; antennis nigris, basi rufo, medio albo-annulato; pedibus rufis, apice tibiarum posticarum tarsisque posticis nigris; alis hyalinis, stigmate nigro. ♀.

Long. 7; terebra 2 mm.

Antennæ longer than the body, slightly thickened towards the apex, black; the scape and the second joint rufous; the sixth to ninth joints clear white, except on the top. Head distinctly wider than the mesothorax; ferruginous, the face pallid yellow; the vertex rather coarsely punctured; the front hollowed, its middle raised; the raised part bordered by stout keels. Face and clypeus punctured, the sides thickly covered with short, silvery hair; the apex of the clypeus rounded, clearly defined from the rest of the clypeus. Mandibles pallid yellow; the apex black, ending in two stout triangular teeth. Mesonotum closely punctured, and covered thickly with short microscopic pile; the sides of the pronotum projecting

at the apex, the projection ending in a blunt triangle, behind which is a smaller, more rounded, projection. Scutellum longer than it is broad, narrowed towards the apex ; the sides at the base stoutly keeled ; the basal depression wide and deep ; the median segment closely rugose, large ; the apex in the middle transversely striated ; in the centre there is only the supramedian and the lateral basal areæ, the former being wide at the base and with the sides oblique ; and the posterior median which is rounded at the base and with almost straight sides ; the spiracular area is large, wide, rounded behind. The propleuræ pallid yellow ; stoutly, obliquely striated on the lower side ; the mesopleuræ coarsely punctured above, the lower stoutly, irregularly striolated ; at the sides of the mesosternum is a wide, deep, longitudinal furrow, marked throughout with stout, vertical keels. Legs rufous ; the apex of the hinder femora, of the hinder tibiæ more broadly and the tarsi, except the base, black. Wings hyaline, the stigma black, fuscous at the base ; the recurrent nervures largely bullated. The petiole is somewhat longer than the second segment, broad, narrow at the base ; down the middle are two distinct keels, which reach to the apex ; the sides are keeled to the spiracles, the keel in front of these diverging on their inner side. The second and third segments are closely punctured ; the sides, apex and ventral surface are pallid yellow.

ERADHA, *gen. nov.*

Entire body densely hairy. Clypeus depressed laterally; its middle projecting into a stout, triangular process. Eyes margined, the head not dilated behind them. Mandibles with two short blunt teeth at the apex. Mesonotum with two furrows down the middle. Scutellum large, flat, slightly longer than it is broad ; the sides stoutly

margined, the margins distinctly raised above the inner portion. Median segment without any distinctly limited areæ, the keels at its base forming irregular reticulations. Metathoracic spiracles oval. Legs very densely hairy, the hinder claws pectinated. Areolet triangular, the transverse cubital nervures uniting at the top; the recurrent nervure is received immediately in front of the second transverse cubital nervure; the second transverse cubital nervure is obscurely bullated on the lower side, the recurrent above and below the middle. The basal half of the petiole is narrowed, the apical widened, the base of the widened part projecting into smooth, shining tubercles. Gastrocœli transverse, shining, moderately deep, placed at the extreme edge of the segment. There are seven segments on the abdomen, which has no ventral keel or fold.

Belongs to the section *Amblypygi* of Wesmael, judging from the fact of there being no longitudinal fold on the ventral surface of the abdomen in the ♂, which is the only sex known. It is very distinct from either *Trogus* or *Amblyteles.* The flat scutellum strongly keeled laterally, the densely hairy body, the median segment without areæ, the triangular areolet and the pectinated claws sufficiently distinguish it from these and from any other described genus.

ERADHA TRICHIOSOMA, *sp. nov.*

Nigra; orbitis oculorum, tibiis tarsisque anterioribus basique tibiarum posticarum late pallide testaceis; alis fusco-hyalinis, nervis stigmateque nigris. ♂.

Long. 16-17 mm.

Antennæ entirely black; stout; the joints of the flagellum slightly dilated at their apices; the scape thickly covered with longish, fuscous, the flagellum with a stiff microscopic, pile. Head black; the upper two-thirds of

the outer orbits narrowly, and the inner entirely, lined with pale testaceous; the line on the inner orbits being wider and dilated in the middle. Face and clypeus coarsely punctured all over, except on the sides of the clypeus which are deeply and widely excavated and smooth; the raised central part of the clypeus is narrowed towards the apex and almost triangular in shape. Except at the base, the mandibles bear large, deep punctures and from the middle to the apex, are covered with long, golden fulvous hair. Thorax entirely black, thickly pilose, that on the pleuræ and median segment being longer and paler than the hair on the mesonotum. The mesonotum strongly and almost uniformly punctured; the scutellum more coarsely and rugosely punctured, at its sides running indistinctly into reticulations; its apex and the greater part of the postscutellum rufo-ferruginous. The median segment has no distinct areæ; the base in the centre has some stout, irregular reticulations; and, on either side of this, is a large, irregular, stoutly bordered area; the entire segment is very roughly rugose and, especially at the sides, thickly covered with longish, white hair. The pronotum behind is lined with a pale rufous band; it is strongly punctured; the punctures on its base less rugose, more widely separated; the mesopleuræ, except in the middle behind, strongly punctured. The centre of the propleuræ is closely, the base of the mesopleuræ is more widely, crenulated; the metapleuræ coarsely, rugosely punctured; behind the spiracles is a smooth, deep, semicircular depression, from the apex of which a curved furrow runs to near the apex of the posterior coxæ. Legs black; the four anterior tibiæ and tarsi and the base of the hinder tibiæ widely pale testaceous; the posterior coxæ are closely punctured except in the middle behind. The triangular areolet receives the

recurrent nervure in its apex, almost touching the transverse cubital nervure. Abdomen strongly punctured, thickly covered with white hair; the second segment entirely and the apical two-thirds of the third rufo-testaceous; at the base of the dilated part of the petiole is a smooth, shining tubercle.

SCALLAMA, *gen. nov.*

Areolet oblique, small, appendiculate to the middle. Antennæ stout, short; the third joint elongate, nearly twice the length of the fourth. Mandibles at the apex with one longish apical tooth. Palpi short and thick. Legs short and thick, the femora dilated; the four hinder tibiæ with two spurs; the hinder large, the outer much larger than the inner, slightly curved, lanceolate; the hinder tarsi thickly covered with stiff, bristle-like hairs; the claws large, thick at the base, the apex hook-shaped, curved, sharp. Mesopleuræ largely projecting in the middle, the base and apex with an oblique slope. Metathoracic spiracles oblique, more than twice as long as broad, rounded at the base and apex. Scutellum flat, not keeled laterally, becoming gradually narrowed towards the apex. Postscutellum large, smooth, flat, depressed at the apex. Petiole broad at the base, becoming gradually wider towards the apex; the other segments flat; the spiracles small, round, situated quite close to the base.

The eyes are large, but do not reach to the base of the mandibles. The head is sharply narrowed behind the eyes, and is not much developed there; the clypeus is not separated from the face at the top on the inner side, the eyes have a distinct, curved incision; there are no furrows on the mesonotum, nor keels on the median segment, except on the sides; the petiole becomes gradually dilated from the base (which is itself broad) to the apex.

The transverse median nervure is received distinctly in front of the basal ; the first recurrent nervure is received shortly behind the middle of the cellule ; the areolet may be absent.

Comes near *Metopius* and *Bassus* in some respects—in the thickened legs for instance—but differs from them in the abdomen not being so broad at the base. Its characteristics are the thickened legs, the mesothorax dilated in the middle, the large flat scutellum, and the distinctly petiolated areolet.

The genus contains two sections. One represented by *S. trilineata*, having a distinct appendiculated areolet, and a keel outside the metapleural spiracles ; the other represented by *S. crassipes*, having no areolet and a keel on the outer and inner side of the spiracles. Unfortunately I have no females, both the species being represented by males.

SCALLAMA TRILINEATA, *sp. nov.*

Fulva, nigromaculata ; alis fulvis ; stigmate fulvo-testaceo, nervis testaceis. ♂.

Long. 11-12 mm.

Antennæ thick, dark fulvous ; the scape yellowish beneath ; covered with longish, pale hair ; the flagellum thickly covered with short, black hair, and becoming gradually and slightly thicker towards the apex. Head deep black ; the clypeus testaceous ; the mandibles and palpi yellow ; the mandibular teeth black and piceous ; the face strongly and uniformly punctured ; thickly covered with long, glistening white hair ; the front and vertex thickly covered with long, brownish hair, which is longer behind the ocelli ; they are covered with shallow punctures ; in front of the ocelli is a triangular depression. In one specimen the eyes have a distinct greenish tint.

Mesonotum shining; thickly covered with short, white pubescence; dark rufous; a broad black band down the centre of the middle lobe; the lateral lobes broadly black at the apex. The scutellum very smooth and shining; thickly covered with long, fuscous hair; the base deep black; deeply depressed, the depression slightly dilated backwards at the sides. The median segment has a gradually rounded slope to the apex, is very smooth and shining, and covered with long, white hair; the base is blackish, and, in its centre behind the postscutellum, is a deep depression, slightly longer than broad, transverse at the base, rounded at the apex; the apex in the middle has a larger depression, longer than broad, rounded at the base, the sides slightly roundly curved inwardly. Propleuræ very smooth and shining, black, broadly rufous at the top; the mesopleuræ shining, obscurely punctured, thickly covered with long, white hair; black, as is also the sternum; in the centre is a curved rufous band, broad at the base, becoming narrowed towards the apex, which ends above the middle coxæ. Legs stout, short; the femora thickened; the tibiæ and tarsi stout, dark rufous; the anterior tibiæ and tarsi obscure yellowish; the fore femora slightly, the four hinder more broadly, black at the base; the apices of the four hinder tibiæ broadly and the hinder tarsi, black; the calcaria rufous; the hinder claws black at the apex. Wings fulvo-hyaline; the costa, nervures and stigma rufous; the nervures at the base darker; the petiole of the areolet is as long as it; its basal nervure is straight, oblique, the apical curved; the recurrent nervure interstitial, and is sharply obliquely curved above the middle; the apex of the curve emitting a short branch from the outer angle. Petiole very smooth and shining, black; the apex broadly rufous; the second segment entirely black; the third black, except at the

sides ; the others are more or less black ; the ventral segments coloured like the dorsal.

The wings vary in tint ; as does the amount of black on the thorax, legs and abdomen.

SCALLAMA CRASSIPES, *sp. nov.*

Nigra; antennis rufis; abdominis medio scutelloque ferrugineis; pedibus rufis; coxis, trochanteribus femoribusque posterioribus nigris; alis fusco-violaceis, stigmate nigro. ♂.

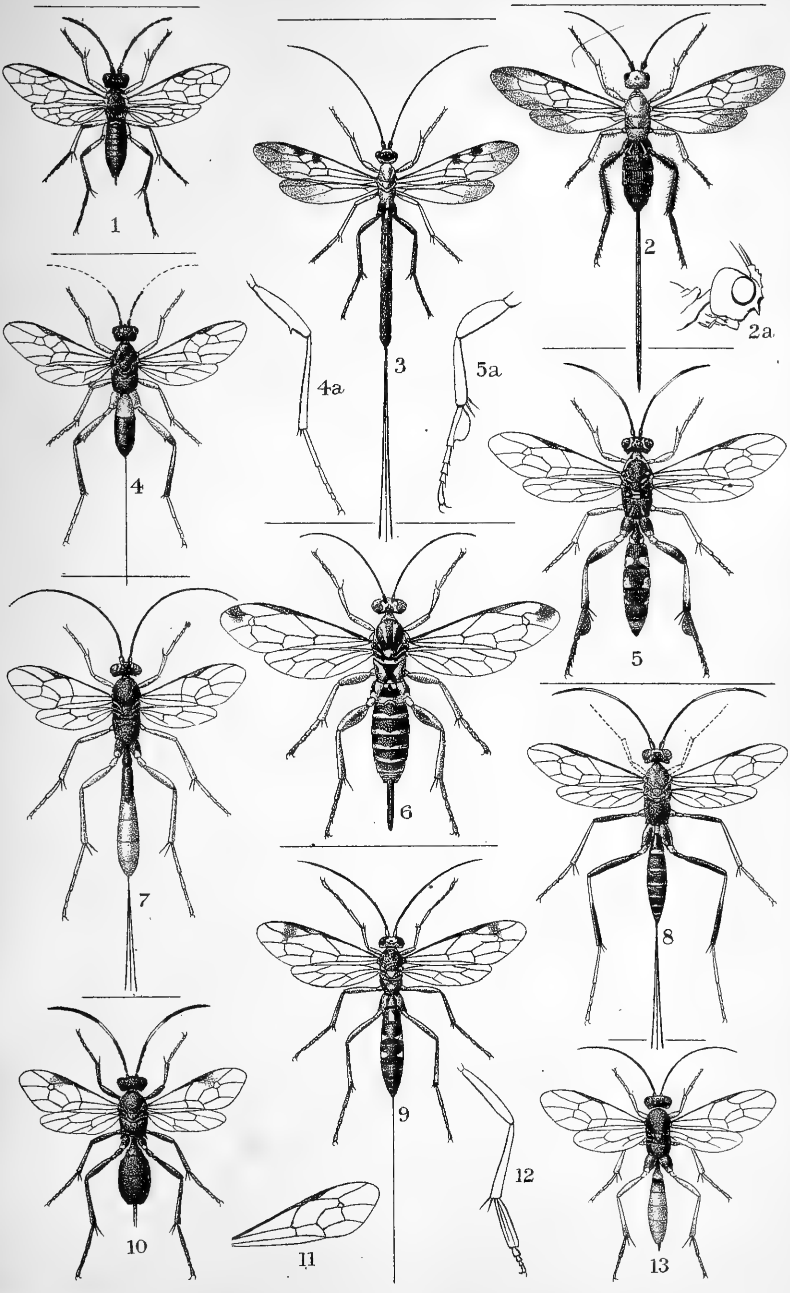
Long. 13-14 mm.

A larger species than *S. trilineata*, from which it may be known by the pleuræ, meso- and meta-notum being entirely black, and by the absence of the areolet.

Antennæ rufous, slightly darker towards the apex, thickly covered with microscopic hair. Head black, the face thickly covered with long, fulvous hair, the occiput thickly with shorter, black hair ; the face strongly punctured. Thorax shining ; the tegulæ, scutellum and post-scutellum rufous ; the mesonotum thickly covered with fuscous, the scutellum with longer fulvous, hair ; the sides of the metanotum with long, pale hair. Pleuræ shining, impunctate ; the mesopleuræ broadly projecting. The anterior legs rufo-fulvous, the middle darker, more rufous in tint, their femora broadly infuscated at the sides ; all the coxæ and trochanters black ; the hinder femora black ; the hinder tibiæ rufous on the basal half ; the apical infuscated ; the tarsi fuscous. Wings fulvous-smoky ; the costa, stigma and nervures dark testaceous ; the second transverse cubital nervure is obsolete ; the recurrent nervure is received shortly in front of the transverse cubital nervure. Abdomen dark rufous ; the basal two-thirds of the petiole and the apical two segments black, thickly covered with pale hair.

EXPLANATION OF PLATE 3.

Fig. 1. *Rethra carinata* ♀.
„ 2. *Chaolta lamellata.* 2*a*. head from the side.
„ 3. *Bracon leptogaster* ♀.
„ 4. *Wroughtonia cornuta.* 4*a*. hind leg.
„ 5. *Eleanta latitarsis* ♀. 5*a*. hind leg.
„ 6. *Chrysopimpla ornatipes* ♀.
„ 7. *Trathala striata* ♀.
„ 8. *Eugalta spinosa* ♀.
„ 9. *Lytarmes maculipennis* ♀.
„ 10. *Rothneyia annulicornis* ♀.
„ 11. *Meyra villosa* wing.
„ 12. *Sunoxa purpureifrons* hind leg.
„ 13. *Bosmina spinipes* ♀.



W Purkiss del. et lith.

HYMENOPTERA ORIENTALIA.

Manchester Memoirs, Vol. xliii. (1899), *No.* **4.**

THE WILDE LECTURE.

IV. The newly discovered Elements; and their Relation to the Kinetic Theory of Gases.

By Professor William Ramsay, F.R.S.

(Delivered March 28th, 1899.)

When a body of any kind, be it solid, liquid, or gaseous, is in a condition in which it can be made to do work, it is said to possess available energy. A coiled spring, a reservoir of water on a hill, a compressed gas; these are all instances of bodies in possession of available energy, for from all of them work may be obtained; from the spring, by allowing it to uncoil, and drive such a mechanism as a watch; from a reservoir of water, by opening the sluice, and utilising the descent of the water under the attraction of the earth to cause a mill-wheel to revolve; from a compressed gas, by allowing it to expand into the cylinder of an engine, and raise a piston. Heat, too, is a form of energy; and its numerical relation to mechanical and to gravitational energy, discovered by your fellow-townsman, Joule, will ever remain connected with his name, and with the city where his discovery was made—*monumentum aere perennius.*

By heating a body, therefore, energy can be communicated to it; it then becomes capable, if placed in appropriate environment, of performing work. The work done by a steam engine is owing partly to the expansion of the compressed steam, partly to its loss of heat in expanding. Every body has its own power of holding heat; a pound of water has much greater capacity for heat than a pound of mercury; that is, it is capable of holding more heat. If the capacities of holding heat are

May 17th, 1899.

referred to equal weights, they are termed specific heats. The term is due to Crawford, and the expression "capacity for heat" dates back to the time when heat was supposed to be an "imponderable form of matter"—a view now long abandoned. Crawford, too, was the first to attempt to measure the specific heats of gases, by enclosing them in thin copper spheres, warming the vessels with their contents, and plunging them into a calorimeter; a plan which, with some modifications, has in recent years met with success in the hands of Dr. Joly. Your fellow-townsman, Dalton, of immortal memory, in repeating Crawford's experiments, began the investigation of a fact which had been previously known, namely, that when a gas is compressed, it grows warm. He showed, in a paper before this Society in 1801, that the converse also holds true; that when a gas is allowed to expand against pressure, it grows cold. Between that early date and the year 1841, attempts were made, more or less successfully, to measure the specific heats of gases; and the idea was rapidly gaining ground that heat was not an intangible and imponderable *substance*, but a form of motion of the ultimate parts of which all bodies are composed, their molecules. This idea, even, was not new, but can be traced back as far as Robert Boyle, who wrote about the year 1660:—"Heat will appear the more likely to be mechanically producible from considering the nature of it. And this seems principally to consist in that mechanical property of matter we call motion; which is subject to three conditions. First, the agitation of the parts must be vehement; second, the determinations [or motions] must be very various, and tend all manner of ways; and third, the agitated particles must be so minute as to be singly insensible."

And again:—"That vehement and tumultuous agita-

tion of the small parts of bodies, wherein the nature of heat seems chiefly, if not solely, to consist."

In the year 1841, a great advance was made by Mayer and by Joule. Mayer regarded the heat evolved by the compression of a gas as equivalent to the work necessary to compress it. At the same time, he indicated a method by which the work equivalent to the heat could be calculated. And Joule determined with great accuracy the amount of heat produced by friction caused by a known quantity of work; a quantity now known as the "mechanical equivalent of heat."

These considerations led to a mechanical conception of heat in its relation to gases. The gases were treated as if they were composed of small particles in motion. The pressure of the gas is caused by the impact of these small particles, or molecules, on the walls of the containing vessel; and the motion is believed to be more rapid when the temperature is raised, according to the kinetic theory of gases. This conception of heat, as due to the motion of the molecules, was developed by Joule, Rankine, Clerk-Maxwell, Sir William Thomson (Lord Kelvin), and by the German physicist Clausius.

Now, when heat is communicated to a gas, and the gas is confined in a tight vessel, so that its volume cannot alter, the pressure on the walls of the vessel rises. As the number of molecules of the gas undergoes no alteration, this increased pressure must be due to the increased rate of motion of the molecules. The increase of pressure can be measured; and it corresponds to an increased power of performing work. The gas, in other words, has gained energy; and it is possible to calculate, from the known rise of pressure, the amount of energy gained by a known quantity of gas, which has been raised through a known temperature (say 1°C), and which has acquired a certain amount of heat thus to raise its temperature. If we take

as the volume of the gas that occupied by 2 grams of hydrogen, 28 grams of nitrogen, 32 grams of oxygen, and so on—numbers proportional to the molecular weights of their molecules—namely 22,222 cubic centimetres; and if we raise the temperature of that volume of gas from 0° to 1°C, the energy gained by the gas, measured in ergs and deduced from the increase of its pressure, is 123,765,000. Knowing from the researches of Joule, and of his successors Rowland and Griffiths, that the value of the mechanical equivalent of heat is 42,750 gram-centimetres, and dividing the ergs by this number, and by the gravitation constant, 981, we arrive at the number of calories equivalent to the energy imparted to the gas. The result is very nearly 3 calories, or, in other words, as much heat as will raise one gram of water through 3°C must be imparted to a "gram-molecule" of a gas in order to raise its temperature through 1°C.

Suppose such a gas, thus raised in temperature through 1°, to be allowed to expand against atmospheric pressure, until its pressure falls to the original value which it had before it was heated, its temperature will fall, owing to the work which it does in "raising the atmosphere." In order to restore it to the temperature 1°C, more heat must be added. The amount of this necessary heat is easily calculated from the known weight of the atmosphere on each square centimetre, and the distance through which it is raised; it is 2 calories, approximately. The first amount of heat—that required to heat the gas at constant volume—is thus 3 calories; the second, required to raise the temperature of the gas under constant pressure, when it is allowed to expand, is $3+2=5$ calories. The ratio between these two quantities is 3 : 5, or 1 : 1·66.

It must be remembered that the assumption involved in these considerations is that the molecules of gases are

hard, elastic spheres, frictionless when in collision with other molecules, or with the walls of the containing vessel. It does not appear probable that molecules are really of such a form, or possessed of such properties. But there can be no doubt whatever, that, granting the premises, the conclusions will follow. They are derived from common mechanical conceptions.

Until the year 1894, the only gas of which the ratio of specific heats attained the value of 1·66 was mercury vapour. The measurement was made by Kundt and Warburg in 1868. Now, there are other reasons in the case of mercury which render it probable that its molecule is of a simpler nature than that of other gases. We are accustomed to compare the density of gases with that of hydrogen, taken as unity. And as, according to the law discovered by Avogadro in 1811, equal volumes of gases, at the same temperature and pressure, contain the same number of molecules, the density of a gas, compared with that of hydrogen, shows the relative weight of its molecule, compared with that of a molecule of hydrogen. Now, mercury-gas is 100 times as heavy as hydrogen, and hence its molecule is 100 times as heavy as a molecule of hydrogen. But the specific heat of liquid mercury is one-two hundredth part of the supposed specific heat of solid hydrogen; and, as the specific heats of elements are known to stand to each other in the inverse ratio of their atomic weights, it follows that the atomic weight of mercury is two hundred times that of hydrogen. The atom of mercury is then 200 times as heavy as the atom of hydrogen, while the molecule of mercury is only 100 times as heavy as the molecule of hydrogen. From this it follows that a molecule of mercury must contain only half as many atoms as a molecule of hydrogen. The simplest statement of this conclusion is that the molecule of hydrogen con-

sists of two atoms, while that of mercury is identical with its atom. And this agrees with the conclusion drawn from the ratio between the specific heats of mercury-gas, namely, that the molecule of mercury-gas is mono-atomic; that it is a smooth elastic sphere.

The ratio between the specific heats of hydrogen, of oxygen and of nitrogen, unlike that of mercury-gas, is 1·4, approximately. This is also the case with carbon monoxide, CO, and with nitric oxide, NO, both of which gases are probably di-atomic. The conclusion would follow by analogy that the molecules of the three elementary gases are also di-atomic, and that their formulæ should be H^2, O^2, and N^2. Gases with three atoms in their molecules, however, do not show such regularity as these; the ratio varies between 1·20 for carbon disulphide, to 1·31 for sulphuretted hydrogen. But generally, it has been found that the greater the number of atoms in the molecule of a gas, the lower the ratio of the specific heats. The physicist, Boltzmann, has devised a theorem to account for this fact. He imagines a molecule consisting of one atom to possess what he terms three degrees of freedom; that is, it may move in space in all conceivable directions, like a fly in the air; but all these directions may be referred to motion in three directions at right angles to each other. A molecule resembling a smooth, elastic sphere, however, is not capable of acquiring by collision with other molecules, or with the walls of the vessel in which it is contained, any motion of the nature of rotation about its axis. On the other hand, a molecule consisting of two atoms possesses, like the former, three degrees of freedom, and, in addition, other two; that is, it is free to rotate in two planes, each parallel to the line joining the centres of its atoms; but it is not free to rotate in a plane at right angles to that line. It thus possesses five degrees

of freedom. But a molecule consisting of three atoms possesses six degrees of freedom, for in addition to the other five, it may rotate in the third plane. In these cases, some of the energy given to a gas when it is heated will be expended in causing such rotational motions, and the specific heat at constant volume of such a gas will be greater than if no such rotational motions were possible. But the heat corresponding to the work done during the expansion of the gas will not be altered thereby; and hence the ratio between the two specific heats of the gas, that at constant volume and that at constant pressure, will be smaller. I need not enter into the details of this theorem, but will merely state that for a gas consisting of di-atomic molecules, the ratio of the specific heats is calculated by Boltzmann to be 1·4, and that of tri-atomic gases $1{\cdot}\dot{3}$. With gases whose molecules contain a still larger number of atoms, and indeed for some of those with three, the inter-atomic motions become more complex, and absorb energy in the form of heat to a still greater extent.

It will be noticed that these ideas of Boltzmann's stand on a very different footing from the first conception by which it is shown that the specific heat ratio for a mono-atomic gas should be $1.\dot{6}$. The problem is more complex, and an entirely different set of considerations is introduced to deal with it. Yet it is very ingenious, and affords a plausible explanation of the found ratio of specific heats of di-atomic gases.

I have ventured to draw your attention to these considerations, because the recently discovered gases of the atmosphere throw some light on the kinetic theory of gases, and support the views which I have endeavoured to make clear to you. I will ask your permission, however, to interpolate here a short account of the discovery of these gases.

I need not remind you how Lord Rayleigh's remarkable observation that the density of atmospheric nitrogen is somewhat higher than that of nitrogen prepared from purely chemical sources, such as ammonia, or nitric acid, led to the discovery of argon. Determinations of its density gave the number 19·94, compared with that of oxygen equal to 16. I may remark in passing that this is the best standard to take for the density of gases, because, if air be adopted, as used to be customary, the standard will vary, inasmuch as air is a mixture of fluctuating composition; if hydrogen be chosen, there is still uncertainty, because the true weight of a litre of hydrogen is still unknown. And add to these reasons the recent decision of the Committee of the German Chemical Society to adopt 16 as the atomic weight of oxygen, and to refer all other atomic weights to the sixteenth part of this number, and it will, I think, be regarded as tending towards accuracy and uniformity.

The atomic weight of argon, however, has given rise to some dispute. Its molecular weight admits of no doubt; it must of necessity be twice its density, namely, approximately 40. But argon, like mercury, shows the ratio between its specific heats of $1\cdot\dot{6}$; and it was argued in the memoir on "Argon, a new constituent of the Atmosphere," that this could point only to one conclusion, namely, that its molecule must be identical with its atom; and its atomic weight therefore identical with its molecular weight, 40. But to this many objections were raised, chiefly on the ground that if 40 were the atomic weight, then there would be no place for the element in the Periodic Table, seeing that it would follow, instead of preceding potassium, the atomic weight of which is 39·1. The hypothesis was thrown out at the time that argon might be a mixture, and contain some heavier gas of

approximate atomic weight 82, which would follow bromine, and precede rubidium, in the Periodic Table. Any considerable admixture of such a gas would necessarily raise the apparent atomic weight of argon; and it might really have an atomic weight less than that of potassium, instead of greater. The anticipation that there is a still heavier gas mixed with atmospheric argon has turned out to be correct; but it is present in such infinitesimal amount, that its removal does not materially influence the density of argon.

Another suggestion, also made at the time of publication of the Argon paper, was that possibly it might contain some diatomic molecules, which would therefore raise the apparent density. This supposition has also turned out to be without support; for there is no change in the relative density of argon with either rise or fall of temperature. It has been heated to 280° without undue expansion; and it has also been cooled to the boiling point of liquid oxygen, −182°, without undue contraction. Had it contained any diatomic molecules, it is almost certain that their number would have been reduced by a rise of temperature, and increased by a fall of temperature such as those to which it has been subjected. The absence of any sign of such increase or reduction makes the existence of diatomic molecules exceedingly improbable. We must therefore be content to admit that its atomic weight is so far anomalous that it is higher, rather than lower, than that of the element which follows it in the Periodic Table.

We may here inquire whether the atomic weight of argon is the only one which is, so to speak, displaced. If it is not, it need occasion no anxiety to find it high. Now, there are two elements, cobalt, on the one hand, and tellurium, on the other, the atomic weights of which are

apparently too high; to agree with its position in the Periodic Table, the atomic weight of cobalt, instead of being 59, and exceeding that of nickel, 58·7, by 0·3, should fall below the latter; and the atomic weight of tellurium, 127·6, (Brauner, Chikashige, Staudenmaier and others), is 0·75 below that of iodine, 126·85, its neighbour in the Table.

But the position of argon in the Periodic Table is thus far vouched for only by the ratio of its specific heats. As it has hitherto formed no compounds, and as its specific heat in the solid state has not been determined, and indeed would present many difficulties in experimental determination, some other clue must be found for the solution of the problem. The problem has been solved, and it is evident that its solution in the sense indicated must also lend additional strength to the arguments in favour of the justice of the kinetic view of the ratio between the specific heats of mono-atomic gases; arguments derived both from a theoretical standpoint, as well as from the known ratio between the specific heats of mercury gas.

The discovery of argon in 1894 was followed early in 1895 by the discovery of helium, an element closely resembling argon in its indifference towards chemical reagents, and also in the ratio between the specific heats; but differing in its density, which is almost exactly 2, and in its spectrum. Other remarkable properties of helium are its unusually low refractivity, and the ease with which an electric discharge can pass through it, even at atmospheric pressure. It appears, also, to diffuse through a porous plug at a rate about 10 per cent. more rapid than would correspond with its density. Moreover, it has the lowest coefficient of solubility of any gas—100 volumes of water dissolve only 0·7 volume of helium.

Arguing from the ratio between the specific heats of helium, in a manner similar to that employed for argon

the atomic weight should be identical with the molecular weight, namely 4. And if that argument holds good, there is room for another element with the atomic weight 20, to fill a gap which should exist between those of helium and argon, as will be seen from the table which follows :—

H = 1	He = 4	Li = 7	Be = 9	B = 11	C = 12	N = 14	O = 16
F = 19	? = 20	Na = 23	Mg = 24	Al = 27	Si = 28	P = 31	S = 32
Cl = 35·5	A = 40	K = 39	Ca = 40	Sc = 44	Ti = 48	V = 51	Cr = 52

But if, on the other hand, the atomic weights of helium and argon are respectively 2 and 20, there is no room for any intermediate element, for, as is evident, all places are filled. I ventured, at the meeting of the British Association at Toronto, in 1897, to prophesy that such an element should exist; and I there gave an account of the efforts which had up to that time been made to seek for it. Suffice it to say, that, in conjunction with Dr. Collie, and later, with Dr. Travers, helium was diffused and re-diffused, with the view of separating from it such a gas, with density 10; so far as this object was concerned, our experiments were a failure, although it was proved that the minerals which yield helium also give off a small quantity of argon. Mineral waters and meteorites were also investigated, but with no positive results; and a great number of uraniferous minerals were heated, and the evolved gas collected; in no case did the spectrum show any trace of lines other than those belonging to helium and to argon. There was, however, still a gleam of hope, for Dr. Collie and I, before beginning our experiments on the diffusion of helium, had submitted argon to systematic diffusion, and had found that the portion collected at first had a density somewhat smaller than the last portion. But as the question regarding the homogeneity of helium was at that time of interest, in consequence of the remarkable work of Professors Runge and Paschen, who showed

that it was possible to classify the spectral lines of helium in two distinct classes, each consisting of three series; and as they had then drawn the deduction, subsequently retracted when they discovered that the spectrum of oxygen admitted of precisely similar analysis, that helium must be a mixture of two gases, it was thought more probable that the unknown gas would be found in crude helium that in crude argon. Hence the experiments on argon were not further followed out.

It appeared probable, from Dr. Johnstone Stoney's ingenious speculations on the "Atmospheres of Planets and Satellites," that the missing gas should be a constituent of the earth's atmosphere; for its presumed density, 10, would render it unlikely that it should escape from the attraction of the earth, by virtue of its own proper motion. It will be remembered that Dr. Stoney entertains the view that while the moon, owing to its comparatively small mass, is incapable of holding on its surface any gas known to us, except, possibly, carbonic anhydride, the earth, owing to its greater mass, is capable of holding all gases with a density greater than about 7; while the enormously greater mass of the sun accounts for the spectrum of hydrogen and of helium having been seen in the light which it emits. Some doubt may be entertained regarding the validity of this theory, seeing that Dr. Travers and I have recently verified the work of Professor Kayser, and of Dr. Friedländer, each of whom, independently, saw the helium lines in the spectrum of atmospheric argon; we have succeeded in isolating the helium in relatively considerable quantity. And still more recently, Professor Gautier has detected hydrogen among the constituents of the earth's atmosphere, not only, as had been done previously, in the atmosphere in the neighbourhood of volcanoes, but in the atmosphere of Paris. Yet, in support of Dr. Stoney's

theory, it may with justice be urged that the escape of gases from the earth's surface is slow, though of course more rapid in the case of the light than of the heavy gases; and that if there is a constant emission of hydrogen or of helium from the earth, it may be replaced more quickly than it escapes. And the fact that the decomposition of animal and vegetable matter is sometimes accompanied by the evolution of hydrogen, and that many hot springs evolve gas comparatively rich in helium, may perhaps account for their occurrence in the atmosphere, in spite of their low densities.

Be this as it may, Dr. Stoney's theory was a considerable factor in inducing Dr. Travers and myself to again examine argon, with a view of finally settling the question of its homogeneity.

Our patience, however, was not equal to the task of fractionally diffusing argon. The experiments on helium lasted over three months, and they involved an immense expenditure of mechanical labour, unenlivened by any results. Moreover, the rate of diffusion of argon is only half as rapid as that of helium, and a similar set of experiments would have taken more than twice as long a time. But the most cogent reason against employing the process of diffusion to effect a separation was, that although by its help, it is possible to separate two gases of widely differing density, if each is present in considerable quantity, it is not an advantageous process, if it be required to separate two gases not differing widely in diffusion rate, and of which one must be present only in minute amount. It will be remembered too that the high density of argon rendered it much more probable that it would contain a small quantity of a heavy gas, than of a light one.

Previous experiments had made it certain that crude argon would contain only a small amount of admixed

gas, if it contained any at all; hence it was necessary to prepare a large quantity from air. A description of the method of preparation of 15 litres has been recently given to the Royal Society, in a paper treating of the properties of pure argon (*Proceedings*, vol. 64, p. 185). Suffice it to say here that it was necessary to deal with no less than 1,500 litres of air; that the oxygen was removed by passage through a large iron tube containing red-hot metallic copper; and that the nitrogen was absorbed by 5 kilograms of metallic magnesium. The resulting crude argon was further purified by passage through tubes containing a mixture of freshly made lime and magnesium dust—a mixture which yields calcium on heating to redness—in order to remove the last traces of nitrogen.

This argon was then liquefied by passing it into a reservoir cooled to about $-205°$C. by means of liquid air, boiling under a pressure of a few centimetres of mercury. It yielded about 17·4 cubic centimetres; it formed a colourless liquid, showing no absorption spectrum. On raising the pressure on the liquid to that of the atmosphere, it boiled; and the first fraction was collected separately. This fraction was then liquefied in its turn in a smaller apparatus, so far as was possible; but a portion resisted liquefaction, in spite of the utmost lowering of temperature which Dr. Travers and I could produce by causing the liquid air to boil at a low pressure, and in spite of increasing the pressure on the gas to over two atmospheres. This gas was weighed, and proved to have the density 9·76, a number closely approaching to the expected density, 10. It has a brilliant spectrum, consisting of lines chiefly in the red and yellow, with a few less conspicuous lines in the green. On photographing the spectrum, an operation carried out by my assistant, Mr. Baly, the characteristic yellow and green lines of

helium were distinctly visible. To the new gas we gave the name "Neon," signifying "new"; and our next endeavour was to free it from the admixed helium. Inasmuch as neither of these gases is liquefiable with the means at our disposal, it was necessary to contrive a method by which they could be separated from each other. It was found in the solubility of both gases in liquid oxygen. The mixture of gases was accordingly mixed with enough oxygen to cause the whole to liquefy, when exposed to the lowest temperature we could reach with liquid air, boiling under low pressure; and the lightest fraction was, as before, collected separately. Its spectrum showed the helium lines much more brilliantly than before, and the residue less brilliantly. But it showed, at the same time, the spectrum of argon. Hence a new fractionation was attempted, in which the gas was divided into three portions, the lowest-boiling of which was still rich in helium; the middle portion showed helium and argon feebly, and neon brilliantly; while the last portion showed merely a trace of helium, but the argon lines were fairly strong, among those of neon. Up till now, we have not succeeded in preparing perfectly pure neon, and we are still engaged in effecting a complete separation. Let any organic chemist imagine that he has to separate a mixture of pentane, hexane, and octane from each other, by fractional distillation, and he will realise the difficulties of the task. Still, there can be no doubt that a fair separation has already been effected, and the density of the purest specimen, 10·04, and 10·19 in two experiments leaves little doubt of the final result; for it may be safely assumed that the higher density of argon will balance to some extent the lower density of helium, and that the true density of neon will not lie far from 10·0. A determination of the ratio between the

specific heats of neon, carried out, it is true, not with the purest specimen of gas, but with a fairly pure specimen, gave the ratio 1 : 1·66, as usual.

This, then, was the long-sought-for element. Its discovery fixes the correct place of argon in the Periodic Table, and with it establishes the justness of the current views on the meaning of the ratio between the specific heats of mono-atomic gases. We must conclude that a gas, with the theoretical ratio, may be imagined to consist of spherical molecules, elastic and frictionless; for, on the kinetic theory, such would be the behaviour of spherical particles with these properties. It may be that some other conformation will equally fit the facts; but of that I am not able to judge. As for the explanation suggested by Professor Boltzmann for the ratio 1·4, found for di-atomic gases, it may be correct; but it is evident that it stands on quite another footing. It is especially to be remembered that it is not fair to place Boltzmann's theory on the same level as that dealing with mono-atomic molecules; and I venture to think that the discovery of neon has placed the latter on a firmer basis.

But there is another gas, remaining as a residue after the evaporation of very large quantities of liquid air, and present in the atmosphere in exceedingly minute amount, which will in all probability lend support to the kinetic theory. We have named it "Xenon," or the "stranger." Up to the present moment we have obtained it in only small quantity; but we are collecting it, and, before long, we shall be in a position to give a full account of its properties. It has not been thoroughly separated from "Krypton," the "hidden," which also remains as a residue on the evaporation of liquid air, and which appears to be an element of approximately the same density as argon, namely, 20, and to be also a mono-atomic gas; nor from argon, which is difficult to separate from krypton. While

the spectrum of krypton is characterised by three conspicuous lines, one red, one yellow, and one green—this last closely coinciding in wave-length with the green line of the aurora borealis—that of xenon is complex, resembling that of argon in general character, but differing totally in the wave-length of its lines. Like the spectrum of argon, too, it is profoundly altered by interposition of a Leyden jar and a spark-gap; the colour changes from an ill-defined purple to a sky-blue, and the spectrum shows the presence of many groups of green and blue lines. The spectrum of krypton, however, in its behaviour towards a discharge of greater intensity is more like that of helium; it undergoes only a slight change. Krypton differs from argon also in its refractivity for light; the refractivity of argon is nearly 0·97; that of krypton is about 1·03; but the refractivity of xenon is evidently much higher, although exact measurements have not as yet been made. Even though the sample we have obtained was evidently far from pure, showing the spectra of both krypton and argon, yet a determination of its density gave a number far in excess of the density of argon. This preliminary weighing proved that we may expect xenon to occupy a vacant space between bromine on the one hand, and rubidium on the other. Continuing the table, of which a portion has already been given, we have the following arrangement:—

	Fe = 56						
Mn = 55	Ni = 58·7	Cu = 63·6	Zn = 65·4	Ga = 70	Ge = 72	As = 75	Se = 79
	Co = 59						
Br = 80	? X = 82	Rb = 85·4	Sr = 87·6	Y = 89	Zr = 91	Nb = 94	Mo = 9
	Ru = 101·7						
? = 100	Rh = 103	Ag = 108·0	Cd = 112	In = 114	Sn = 118	Sb = 120	Te = 128
	Pd = 106						
I = 127	? = 130	Cs = 133	Ba = 137	La = 138	Pr = 140	Nd = 144	? = 146
	? = 152						
Sa = 150	? = 153						
	? = 154	etc.		etc.			etc.

Now, the density actually found for impure xenon was 32·5, a number which implies an atomic weight of at least 65; it will be noticed, however, that 65 is the atomic weight of zinc, and that there follow in order gallium, 70, germanium, 72, arsenic, 75, selenium, 79, and bromine, 80; and that the first gap in the table occurs between bromine and rubidium, as before stated. It is highly probable that when the xenon has been sufficiently purified, its density will prove to be about 41, implying an atomic weight of 82. If this turns out to be the case, it will furnish an additional proof of the correctness of the interpretation of the theoretical ratio of specific heats, on the kinetic theory of gases.

In conclusion, it will be remarked that there is still room for an element with atomic weight 130 to occupy a position between iodine and cæsium. I do not despair of its being found, possibly in air. It is not unlikely that it may be present in extremely minute amount, for its boiling point will doubtless lie not far below zero centigrade. We may not unfairly expect a ratio between the boiling points of neighbouring elements, such as the following:—

	Fluorine	Chlorine	Bromine	Iodine	Neon	Argon	Xenon	?
°Abs. ...	88	238	332	457	33	86	123	169
°Cent....	− 185	− 35	+ 59	+ 184	− 241	− 187	− 150	− 104

With full acknowledgment of the speculative nature of this inquiry at the present stage, one fact is certain; that the boiling point of argon lies 152° lower than that of its neighbour, chlorine. We are well aware, from countless examples, that the boiling points of all substances are raised

by polymerisation ; and the low boiling point of argon, which has an atomic weight somewhat higher than that of chlorine, and which might be expected, therefore, to boil at a higher temperature than chlorine, is without doubt due to its mono-atomic nature. The boiling point of neon lies below the lowest temperature which can be reached by reducing the pressure on boiling air, a temperature which has been estimated as $-215°C$. And the boiling point of xenon is so high, that at the temperature of boiling air, its vapour pressure is only a few millimetres of mercury.

Further research will solve these problems, which are among those which suggest themselves in connection with the newly discovered elements of the air.

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V. On the Slipperiness of Ice.

By Professor Osborne Reynolds, F.R.S.

Received and read February 7th, 1899.

The slipperiness of ice is, and has been, one of the most noticeable, interesting, and important circumstances under which we live, as well as one of the commonest. Ice is not the only slippery thing in the world, but it is the only one of all the solid substances which, in the condition nature has left them on the surface of the earth, possesses the property of perfect slipperiness. This being so, and being commonly known to be so, it is certainly remarkable that, whatever may be the reason, there appears to have been little or no curiosity as to the physical significance of the unique property which ice possesses. Speaking for myself this is simply explained; ice was slippery when I was born, I never knew it otherwise, and, to put it shortly, it was slippery because it was ice, whereas it now seems to me that, of all the secrets nature has concealed by her method of deadening curiosity by leaving them exposed, in this her method has been the most successful.

The cause of my ultimately discovering the secret, unsought by me, was an accident, though brought about by another line of research. The other sources of perfect slipperiness are complex; a smooth solid surface covered by a viscous fluid, as a well-greased board, is perfectly slippery just as ice is, which fact had been taken for granted much in the same way as the slipperiness of ice, neither more nor less.

June 6th, 1899.

That surfaces of machines would not slip over each other without grease was well known and followed out, but the physical significance of the action was apparently not questioned until, in 1884, Mr. Beauchamp Tower,* while making experiments as to the resistance of a railway journal, accidentally came across a fact of very striking significance.

In this experiment, instead of using an axle, Mr. Tower used an overhanging shaft driven by a steam engine, the shaft being supported on bearings in the usual manner. The overhanging portion of the shaft was turned to the same shape as one of the journals of a railway wheel, four inches in diameter and six inches long. On this journal the ordinary axle-box was suspended, the load to correspond with the proportion of the weight of a loaded truck being suspended from the axle-box underneath the shaft. The axle-box had the usual brass wearing-piece, and the provision for lubrication was, as usual, an oil or grease cup communicating through a vertical oil-hole, so that the oil might descend by gravitation through the brass on to the surface of the journal, and thence escape, after being used, to the ground. This was in the first instance, but, after experimenting in this way, Mr. Tower proceeded to find what would be the effect on the resistance if, instead of allowing the oil or grease to escape freely from underneath the journal, the whole under side of the journal was encased in a vessel, so as to form a bath of oil in which the journal would be completely covered.

In commencing these experiments with the bath, Mr. Tower noticed with surprise that, although the oil in the bath did not cover the top of the brass when the journal was at rest, when in motion the oil escaped upward against

* *Proc. Inst. M. E.*, Nov. 1883 and Jan., 1884.

gravity through the oil-hole, and as this was inconvenient, tending to empty the bath, he drove a plug of wood into the hole and tried again, when to his still greater surprise he found that the oil forced out the wooden plug. This led him to fit a pressure gauge to the hole; this immediately rose to the top of its scale, 200 lbs. per square inch. Then, realising that he had before him evidence of an action in lubrication until then unsuspected, Mr. Tower turned his attention to its experimental investigation, finding that when the journal was run at 400 revolutions a minute, the pressure on the square inch indicated on the gauge was somewhere about 3/2 of the pressure necessary, if distributed over the whole horizontal area of the section of the bearing, to sustain the load. The pressure in the oil-hole would be 600 lbs. per square inch when the total load was 9,600 lbs., whence, as the area of the horizontal section was 24 square inches, the mean intensity of pressure would be 400 lbs. This, however, was only when the speed of the journal was greater than a certain limit depending on the load; when the speed diminished below this limit, the pressure on the gauge fell to any degree below that necessary to sustain the load. But this was not all. When the speed was such as to sustain the load, the friction was 1 in 400, but when running slow the friction reached 1 in 3, or the journal seized the brass.

Taking these two things together, it made clear the fact which had never been surmised before, that the *action of lubrication consisted in the actual separation of the solid surfaces* by a film of fluid of finite thickness.

These discoveries of Mr. Tower excited great interest at the time, and, being myself occupied in the study of fluid motion, I was induced to undertake the theoretical analysis of Mr. Tower's experimental results, from which, after two years' work, I was able to publish a complete

theory of lubrication,* showing that not only in the case of the oil-bath, when the thickness of the separating film of oil was about 2/1,000th of an inch, but in cases of ordinary lubrication where the thickness of the film is less than ·0001 of an inch, the surfaces are separated by a complete film.

This is very strikingly indicated by a rarely shewn but simple experiment. Two cylindrical hard steel gauges, male and female, one inch in diameter, made to gauge to within 1/20,000th of an inch will not pass one into the other, if wiped as clean as possible of all oil, without the use of great pressure or of a mallet. If oiled and kept moving they can be easily passed one into the other. But should the motion be arrested for a second, they seize and can only be separated by the mallet, which shows that a film of oil less than the 1/20,000th of an inch is sufficient to sustain perfect slipperiness, while the least contact destroys this property.

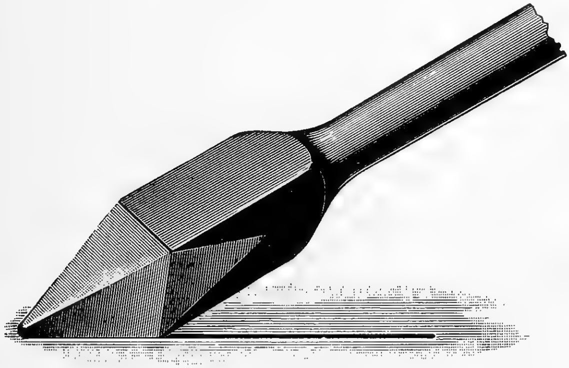
My research also led to the recognition that the property on which the lubricating action depends is the viscosity of the fluid, and that all fluids are lubricants, provided they are not corrosive. Air lubricates, as is shown by the floating of one true surface plate on another with perfect slipperiness. Now water had, at the time, not been recognised as a lubricant; its viscosity is from 200 to 400 times less than oil, but from my research it appeared that it is a lubricant in proportion to its viscosity.

All this is now matter of history, and its bearing on the slipperiness of ice may not as yet be clear. But it has a fundamental bearing nevertheless.

It was about 1886, while I had this subject of lubrication very fresh in my mind, that I was, for some reason,

* *Phil. Trans.* 1880, Part I., pp. 157—234.

using a common soldering-iron, and was in the act of testing the copper point of the hot iron to see if it was hot enough to melt the solder, when, from some cause or another, instead of merely touching the block gently with the point of the copper, I must have pushed the sloping edge obliquely and somewhat roughly on to the flat top of the block, for, to my surprise, instead of melting a little pock in the surface, the square-edged side of the copper slipped without friction right along the face of the solder. It was a perfectly casual accident, but, under the circumstances, it caused me a sense of mental shock as I instantly recognised the analogy to the *skate.*



The barely hot enough, parallel sharp edge of the copper, pressed and pushed forward on the block, was just able to melt the immediate surface, which completely lubricated the iron on the solder beneath. The then well-known property of the lowering of the melting point of ice under pressure at once presented itself; the shock was the result of the instantaneous reflection that I had never before thought of considering why ice was slippery.

On trying to remember whether I had ever heard of any attempt to explain the slipperinesss of ice in any way—for I felt at the moment as though every-

one was laughing at me—I found that I could not call any mention of the subject. And then, in self-extenuation, I reflected that water was not recognised as a lubricant, so that even James Thomson himself, or his brother, Lord Kelvin, might have failed to realize that the melting of the ice under the pressure of the skate would lubricate the moving skate, and rendered the ice slippery to any hard body pressed against it. I also reflected, that had not my mind been full of the circumstances of lubrication, including the lubricating properties of all fluids, I should not have recognised in the slipping of the hot iron the action of the lubricant, and that, even if I had, I should not have attributed like properties to melted ice.

Of course, this evidence as to the cause of the slipperiness was altogether one-sided, and it was still open for ice to have other properties which would account for the slipping besides the property of melting under pressure, and it was at once plain that to render the evidence complete it was necessary to show that, under circumstances of temperature and pressure such that the pressure was nowhere sufficient to melt the ice, the property of perfect slipperiness of ice did not exist.

Looking carefully into the matter from the theoretical side, with Lord Kelvin's determination of the laws of the melting point, 0·014° F. for each additional atmosphere, it appeared that taking a weight of 140 lbs., and an area of $1 \cdot 4/10 (= 1/7)$ square inch, a man skating would melt ice of 31° F. with a skate-bearing of $1 \cdot 4/10$ square inch, while to melt ice at a temperature of 22° F. the bearing must be reduced $1 \cdot 4/100\ (= 1/70)$ square inch. That is, the ice at 22° F. would have to be able to sustain a pressure up to 10,000 lbs. on the square inch. That ice should stand such pressure at first sight seems unlikely, but then our

general impression as to the hardness of ice is derived from ice at or near its melting point.

That this theory admits of experimental verification is certain, but such experiments only become possible when the general surroundings are at a temperature of 22°F.

It was this consideration which caused me, in the first instance, to delay any publication of the facts I observed until there came a frost sufficient for my purpose. There have been frosts of sufficient extent when my preparations were not ready, and my preparations have been ready when there were no frosts ; until, at last, my patience has given way and I have determined to wait no longer. In taking this decision, however, I have been greatly influenced by my general observations on the effect of the temperature on the ease of skating, and on the liability to slip. I notice that without great care you cannot walk on ice at 31½° in leather boots without nails, whereas you can walk safely with boots with somewhat blunt nails under the same circumstances; with a temperature of 27° you can walk with leather boots almost as safely as on any polished floor, while with somewhat blunt nails it is very unsafe to walk on uneven ice.

On ice near 32° skaters find no resistance however slowly they may move, while on hard ice it is necessary to move quickly, or the skates seize, showing that the ice melts under the edge, but owing to the small area of the lubricating surface, the lubricant is squeezed out rapidly, thus destroying the lubrication below certain speeds, as in Mr. Tower's experiment.

But the circumstance that has most confirmed me in the view that the slipperiness of ice is due to the lubrication afforded by the melting under pressure is a casual but emphatic statement made by Dr. Nansen, in his book on Greenland, that at the low temperatures he there encountered the ice completely lost its slipperiness.

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VI. The Plague in Uganda.

By the RIGHT REV. BISHOP HANLON, Uganda.

[*Communicated by Alexander Hodgkinson, M.B.*]

Received and read February 21st, 1899.

Having seen in the English papers of last July, notices of Dr. Koch's discourse on the 'Plague in Uganda,' I would remark on this point that Dr. Koch never came up the lake at all, although I believe he did send a man up. The only plague he can refer to is what is known here as "Kaumpuli," which I have previously described in my letters as akin to the black plague which once scourged London. It begins suddenly, there is high fever, and a swelling, usually under the arm-pit. Like many plagues, it has both a mild and virulent form. The former is not attended with much fever, the swelling moves about the body from place to place, and, should it get near the heart or into the throat, death may result. In the latter form the swelling seems stationary, either under the arm-pit or in the fork of the legs; if the patient be not speedily attended to, a fatal termination results, as often happens to sufferers before their case is known to a European. This form is considered very infectious; the natives shun the sick person and will on no account bury those who die of this form of "Kaumpuli"; they even remove from the neighbourhood of the hut where the person died.

The French Fathers think that one of their missionaries died of it—years before our arrival—after

attending a stricken man, they are not sure, however, of this being the cause of his death. In our own experience of over three years, we have known of only one case. The man lived near the mission of Nagalama, but was dead before anything was known to the missionaries about his sickness. He had been working at the mission, well and hearty, the day before. Father Prendergast could get no natives, not even the most intimate friends of the deceased, to come and bury the body; he was therefore obliged himself to wrap the body in several bark-cloths and bury it. We frequently have cases of the milder form, but I have not heard of any deaths through it.

The natives have a remedy for the disease, but never have it ready at hand when required; the missionaries therefore prepare it. It consists of a certain insect—a fly common enough here: many of which are crushed and mixed with vinegar, and the mixture rubbed on the swelling. The patients are so frightened when they have an attack of the disease, that our greatest fear is lest they die from sheer fright.

It is not correct to state that this disease, so long endemic in Uganda, "has recently travelled to Buddu." Buddu has for *many* years been the centre of this plague in its worst form. Dr. Koch, I see, states that it has travelled from other parts of Uganda to Buddu, and thence south to German territory. I believe the very contrary to be the fact; that it has come from the south. What is now known as the German East African territory has been for many generations—longer than anyone knows—the chief Arab route into this part of Africa. It was *the* great slave route to and from the district of the Lakes. Speke and Grant travelled by it, Stanley travelled by it, the first Uganda Missionaries came that way, and

the French Fathers have ever used it. Our northern route is comparatively new.

Buddu, where, as far as I can make out, this plague has always been worst, is the most southerly province of Uganda and lies next to German territory. It is on the route which has always been used, whether by land or water, from the south to Uganda. The eastern coast of Lake Victoria and the route north through Kavirondo are comparatively little known even up to the present day. Not only has this plague not recently travelled to Buddu, but of recent years it has been less severe there than formerly. I have quite lately heard from a German, who has just come from the south of the Lake, that the plague is at present confined to a small area in Bukola, in German territory, just below Buddu. So that, if this plague has made its way to Central Africa on the track of Arab caravans, I think we must in all fairness assign German East African territory as the way by which the plague has been introduced. Of course this is only an opinion, resting on the arguments given above. If the plague had been introduced by the Mombasa route to Uganda, there ought to be traces of it between here and the coast, but I have never heard of any. The same remark, however, would apply to the German route. But why should not such a plague have broken out here from original germs as in China, or as the Great Plague in London, without necessarily being introduced from such long distances? The wonder is that there are not many more plagues arising from the vast net-work of undrained swamps in this part of tropical and equatorial Africa.

VII. A New Version of Argand's Proof that every Algebraic Equation has a Root.

By Prof. HORACE LAMB, M.A., F.R.S.

Received and read March 7th, 1899.

1. The classical proofs of the theorem in question are for the most part long, and to some minds not very attractive. It may be worth while to indicate how by means of a theorem which, although of a 'transcendental' character, is (in another connection) thoroughly familiar to most mathematicians, the matter can be presented in a very simple form.

Denoting by $f(z)$ a rational integral function of z let us write, as usual,

$$z = x + iy = re^{i\theta} \qquad (1),$$

$$f(z) = u + iv = Re^{i\Theta} \qquad (2),$$

so that R and Θ denote the 'modulus' and 'amplitude', respectively, of $f(z)$, viz.,

$$R = \sqrt{(u^2 + v^2)}, \quad \Theta = \tan^{-1}\frac{v}{u} \qquad (3).$$

Since R becomes infinite with r, and cannot be negative, there must be some finite point in the plane xy at which R attains a lower limit. This limit cannot be other than 0, for then log R would have a finite minimum value. This is (by a well-known corollary to Green's theorem) impossible, since the function $\phi = \log R$ satisfies the equation

$$\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dy^2} = 0 \qquad (4),$$

and is (together with its first and second derivatives) finite,

for all finite values of x and y which do not make $R=0$. Hence there must be some finite value of z which makes $R=0$, $f(z)=0$.

The leading idea of this argument is identical with that of Argand's original proof,* but the theorem that a function ϕ satisfying (4) and the other conditions indicated cannot have a minimum (or maximum) value allows the reasoning to be put very succinctly.

The method involves, of course, the assumption that a continuous function (in this case a function of two variables) does actually attain its lower limit. Scruples on points such as this did not as a rule gain currency until a much later period; but it is of interest to note, as a matter of mathematical history, that the stringency of Argand's argument was questioned at the outset, on precisely this ground, by Servois.† The reply made by Argand‡ is hardly successful from a modern standpoint, and indeed the general recognition of the fact that there *is* an assumption in the matter, and the formulation of a regular demonstration by Weierstrass, belong to quite recent times.

2. The proof above given forms, in a way, the counterpart of a well-known investigation by Cauchy.§ If ds be an element of arc of a curve in the plane xy, and dn an

* *Ann. de Math.*, t. 4, p. 133; t. 5., p. 197 (1815). A modern version is given in Chrystal's *Algebra*, t. 1, c. 12, § 22, and in many Continental works.

† *Ann. de Math.*, t. 4, p. 222. "Ce n'est point assez, ce me semble, de trouver des valeurs de x qui donnent au polynôme des valeurs sans cesse décroissantes; il faut, de plus, que la loi du décroissement amène nécessairement le polynôme à *zéro*, ou qu'elle soit telle que *zéro* ne soit pas, si l'on peut s'exprimer ainsi, *l'asymptote* du polynôme."

‡ *Ibid.*, p. 197.

§ Reproduced by Todhunter and Burnside in their treatises on the *Theory of Equations.*

element of the normal to ds, the positive directions of these elements having the same relation to one another as the positive directions of x and y, then $\phi+i\psi$ being any function of $x+iy$ we have

$$\frac{d\phi}{dn}=\frac{d\psi}{ds}, \qquad \frac{d\phi}{ds}=-\frac{d\psi}{dn} \quad . \quad . \quad (5).$$

Hence, integrating round a closed curve which does not pass through any singular points, we find

$$\int\frac{d\phi}{dn}ds=\int d\psi \quad . \quad . \quad . \quad . \quad (6),$$

and

$$\int\frac{d\psi}{dn}ds=-\int d\phi \quad . \quad . \quad . \quad (7).$$

As a particular case we may put

$$\phi=\log R, \qquad \psi=\Theta \quad . \quad . \quad . \quad (8).$$

where R, Θ are defined by (3). Cauchy shows that the value of

$$\int d\tan^{-1}\frac{v}{u}$$

taken round any circuit which does not include a zero of $f(z)$ is zero, and it follows from (6) that for such a circuit

$$\int\frac{d\log R}{dn}ds=0 \quad . \quad . \quad . \quad (9).$$

From this we may infer the non-existence of a minimum value of $\log R$ within any region not containing a zero of $f(z)$.

It follows also from (7) that the integral

$$\int\frac{u\dfrac{dv}{dn}-v\dfrac{du}{dn}}{u^2+v^2}ds \quad . \quad . \quad . \quad . \quad (10).$$

taken round any closed circuit which does not pass

through zeros of $f(z)$, vanishes, whether the circuit *include* such zeros or not.

3. Another proof of our theorem, still simpler than that of §1, in that it does not involve the logarithmic function, may be obtained as follows.

We have

$$\frac{1}{f(z)} = \frac{1}{u+iv} = \frac{u-iv}{u^2+v^2} \quad . \quad . \quad . \quad (11).$$

The function $u/(u^2+v^2)$ vanishes at infinity, and it cannot have a finite upper or lower limit since it satisfies (4). It follows that there must be some point for which $u=0$, $v=0$, simultaneously.

VIII. Some Preliminary Experiments on the Effect of Pressure on Thermal Conductivity.

By Charles H. Lees, D.Sc.

Received and read February 21st, 1899.

Recent attempts which have been made to re-calculate the age of the earth from the present rate of increase of temperature downwards—the method used by Lord Kelvin—have directed attention to the very small amount of information we possess as to the effect of increase of temperature and pressure as we proceed downwards, on the thermal conductivity of a given substance. A short time ago some information on the temperature effect was published, and the present experiments are an attempt to furnish information on the other point. They were carried out with a simple apparatus consisting of three horizontal circular steel discs 7·9 cms. diameter, between which two similar discs of the substance to be tested were placed. The centre steel disc 2·2 cms. thick had a flat insulated spiral coil of platinoid wire embedded in it with its plane parallel to the flat surfaces of the disc and midway between them. The two ends of the coil projected from the disc and could be connected through an ammeter and a regulating resistance to a number of storage cells. The upper and lower steel discs 1·1 cms. thick, formed respectively the bottom and top of two vessels through which a constant stream of tap water could be maintained. The thickness of each disc to be tested was chosen so that approximately the same amount of heat would flow through the various specimens under the same

difference of temperature. The surfaces of the steel discs and of the discs of material tested were carefully ground on a flat surface so that they would be approximately plane. Thermal contact between surfaces of steel and specimen was improved by smearing both with glycerine and sliding them together. On placing the pile of discs in a small hydraulic press, and applying a pressure equal to that at which the test was to be carried out,any excess of glycerine was forced out and was removed with a cloth. During subsequent decrease or increase of pressure the edge of the film that remained was watched to see whether glycerine was drawn into or forced out of the interval between two discs, but no such motion could be detected, and it has therefore been assumed that the glycerine films remained of constant thickness throughout an experiment. The pressure having been reduced to a few pounds on the square inch or to zero, water was sent through the upper and lower steel discs, and a measured electric current through the coil embedded in the middle disc. The heat generated in the coil raised the temperature of the disc in which it was placed, and in consequence, a flow of heat from the middle to the upper and lower steel discs through the discs of material under test, was established. The temperature of the discs, indicated by 4 thermometers in radial holes in the steel discs close to the flat surfaces, became after some time steady, or nearly so, and observation of temperatures of discs and air surrounding them, and of current were then made and repeated every 5 minutes for an hour. The pressure on the discs was then increased to about 800lbs. per square inch, and after a short time observation taken for another hour. Finally the pressure was decreased to a few lbs. or to zero, and readings taken for a third hour. The discs were then taken apart, one

of those under test weighed, the glycerine films washed off, the disc dried and again weighed. From the decrease of weight an approximate value for the thickness of each glycerine film was obtained.

The temperature indicated by the thermometers not being identical with those of the surfaces of the discs tested, a small correction has to be applied to these indications. Let θ_1 and θ_2 be the temperatures indicated on the thermometers, the centres of the bulbs of which are t_1 and t_2 cms. from the surfaces in contact with the glycerine film, and let t be the thickness of each of the two glycerine layers between the surfaces of steel and material. Then if r is the radius of the discs, and H the amount of heat transmitted per second, the heat transmitted per sq. cm. $= H/\pi r^2$, and if k_1 is the thermal conductivity of steel and k that of glycerine, this flow of heat will cause falls of temperature $Ht_1/\pi r^2 k_1$ and $Ht_2/\pi r^2 k_1$ in the steel discs, and $Ht/\pi r^2 k$ in each of the glycerine layers. If θ_2 is greater than θ_1 the temperatures of the surfaces of the disc tested are therefore

$$\theta_2 - \frac{H}{\pi r^2}\left(\frac{t_2}{k_1} + \frac{t}{k}\right) \text{ and } \theta_1 + \frac{H}{\pi r^2}\left(\frac{t_1}{k} + \frac{t}{k}\right)$$

respectively.*

It was found extremely difficult to secure a constant temperature of the outer steel discs owing to the slow change of temperature of the water from the mains, and this necessitated the treatment of the flow of heat and distribution of temperature in the pile of discs as an "unsteady" one.

* In the experiments mentioned at the end of this communication, H never exceeds ·4, and t never ·005, hence taking k for steel $=$ ·15 and for glycerine ·007, since $\pi r^2 = 50$, and $t_1 = t_2 =$ ·5, we see that the correcting terms never exceed ·027° for the steel and ·006° for the glycerine, while $\theta_2 - \theta_1$ was 3° or 4°. In the deduction of the results given, these corrections have therefore not been applied.

The expression for the temperature at any point, which admits of most easy treatment and is quite capable of representing the changes to be dealt with is $v = V + Ue^{\beta t}$, where β is a small constant and V and U are constants chosen to best represent the observed temperature at any one of the four surfaces of the two discs of material tested.

A solution of the equation

$$\frac{dv}{dt} = a^2\frac{d^2v}{dx^2} - b^2v,$$

where $a^2 = \frac{k}{c\rho}$, $b^2 = \frac{hp}{qc\rho}$,

c the specific heat, q the area, p the perimeter of the cross section, k the conductivity, h the emissivity of the disc tested,

which satisfies the conditions, $v \equiv V_0 + U_0e^{\beta t}$ when $x = 0$, $v \equiv V_1 + U_1e^{\beta t}$ when $x = l$ the thickness of disc, and $\beta > b^2$, is

$$v = \frac{V_1 \sinh\frac{bx}{a} + V_0 \sinh\frac{b}{a}\overline{l - x}}{\sinh\frac{bl}{a}}$$

$$+ \frac{U_1 \sinh\frac{\sqrt{b^2+\beta}}{a}x + U_0 \sinh\frac{\sqrt{b^2+\beta}}{a}.\overline{l-x}}{\sinh\frac{\sqrt{b^2+\beta}}{a}.l}e^{\beta t}$$

At $x = l$

$$\frac{dv}{dx} = \frac{b}{a}\left\{V_1 \cosh\frac{b}{a}.l - V_0 \operatorname{cosech}\frac{b}{a}l\right\}$$

$$+ \frac{\sqrt{b^2+\beta}}{a}\left\{U_1 \cosh\frac{\sqrt{b^2+\beta}}{a}l - U_0 \operatorname{cosech}\frac{\sqrt{b^1+\beta}}{a}l\right\}e^{\beta t}$$

or, since $\frac{bl}{a}$ is small,

$$= \frac{1}{l}\left\{v_1 - v_0 + \frac{1}{3}\frac{b^2l^2}{a^2}(v_1 + \tfrac{1}{2}v_0) + \frac{1}{3}\frac{\beta l^2}{a^2}(U_1 + \tfrac{1}{2}U_0)e^{\beta t}\right\}$$

Taking the mean value of each observed temperature

during the time T, and indicating it by $\overline{v}_1$, $\overline{v}_o$, &c., we have:—

$$\text{mean } \frac{dv}{dx} = \frac{\overline{v}_1 - \overline{v}_o}{l} + \frac{1}{3}\frac{b^2}{a^2} \cdot l(\overline{v}_1 + \tfrac{1}{2}\overline{v}_o) + \frac{1}{3}\frac{\beta}{a^2} l(U_1 + \tfrac{1}{2}U_o)\left(1 + \frac{\beta T}{2}\right)$$

$$= \frac{\overline{v}_1 - \overline{v}_o}{l} + \frac{2}{3}\frac{h}{rk} l(\overline{v}_1 + \tfrac{1}{2}\overline{v}_o) + \frac{1}{3}\frac{\beta c\rho}{k} l(U_1 + \tfrac{1}{2}U_o)\left(1 + \frac{\beta T}{2}\right).$$

a similar equation with $\overline{v}_1$, $\overline{v}_o$, U_1, U_o and l accented, holding for the other disc.

If $\overline{H}$ is the mean rate of generation of heat in the heating coil embedded in the middle steel disc, v_1 and v_1' the temperatures of the two halves of the disc, M its mass, C its specific heat, S its surface and h its emissivity, the mean heat transmitted per second to the discs of material under test

$$= \overline{H} - \frac{MC}{2}\left(\text{mean } \frac{dv_1}{dt} + \text{mean } \frac{dv_1'}{dt}\right) - Sh\frac{\overline{v}_1 + \overline{v}_1'}{2}$$

$$= \overline{H} - MC\beta\frac{U_1 + U_1'}{2}\left(1 + \frac{\beta T}{2}\right) - Sh\frac{\overline{v}_1 + \overline{v}_1'}{2}.$$

Hence

$$\overline{H} - MC\beta\frac{U_1 + U_1'}{2}\left(1 + \frac{\beta T}{2}\right) - Sh\frac{\overline{v}_1 + \overline{v}_1'}{2}$$

$$= \pi r^2 k \left\{ \begin{array}{l} \dfrac{\overline{v}_1 - \overline{v}_o}{l} + \dfrac{2}{3}\dfrac{h}{rk} l(\overline{v}_1 + \tfrac{1}{2}\overline{v}_o) + \dfrac{1}{3}\dfrac{\beta c\rho}{k} l(U_1 + \tfrac{1}{2}U_o)\left(1 + \dfrac{\beta T}{2}\right) \\ + \dfrac{\overline{v}_1' - \overline{v}_o'}{l'} + \dfrac{2}{3}\dfrac{h}{rk} l'(\overline{v}_1' + \tfrac{1}{2}\overline{v}_o') + \dfrac{1}{3}\dfrac{\beta c\rho}{k} l'(U_1' + \tfrac{1}{2}U_o')\left(1 + \dfrac{\beta T}{2}\right) \end{array} \right\}$$

or

$$H - h\left\{ \begin{array}{l} \left(\dfrac{S}{2} + \dfrac{4\pi r l}{6}\right)\overline{v}_1 + \dfrac{\pi r l}{3}\overline{v}_o \\ + \left(\dfrac{S}{2} + \dfrac{4\pi r l'}{6}\right)\overline{v}_1' + \dfrac{\pi r l'}{3}\overline{v}_o' \end{array} \right\}$$

$$-\beta\left\{ \begin{array}{l} \left(\dfrac{MC}{2} + \dfrac{2\pi r^2 c\rho l}{6}\right)U_1 + \dfrac{2\pi r^2 c\rho l}{12}U_o \\ + \left(\dfrac{MC}{2} + \dfrac{2\pi r^2 c\rho l'}{6}\right)U_1' + \dfrac{2\pi r^2 c\rho l'}{12}U_o' \end{array} \right\}\left\{1 + \frac{\beta T}{2}\right\}$$

$$= \pi r^2 k\left\{\frac{\overline{v}_1 - \overline{v}_o}{l} + \frac{\overline{v}_1' - \overline{v}_o'}{l'}\right\}.$$

By means of this equation k can be calculated from the observations.

In order to determine the value of h for the discs, an experiment was made in which the discs under test were air enclosed by a ring of silk ribbon. The heat conducted through the air being small, the right-hand side of the above equation is nearly zero, and the heat H is almost entirely lost from the surfaces of the discs.

The materials tested by the above method were glass, ebonite, marble, slate, sandstone, and granite, of thickness varying from ·2 to 2 cms., according to the conductivity of the material. Up to a pressure of 800 lbs. on the square inch no change of thermal conductivity was found in the cases of granite and marble, a slight increase in the cases of glass and ebonite, and an increase of 4 or 5 per cent. in the case of the soft sandstone.

As the changes are so small that the correction due to the glycerine layer is quite comparable with them, it is proposed to carry out the experiments with a contact film of mercury instead of glycerine, and with this end in view the surfaces of the steel discs have been copper-plated and amalgamated.

Manchester Memoirs, Vol. xliii. (1899), *No.* **9.**

IX. Description of a genus and species, probably representing a new tribe of Hymenoptera from Chili.

By P. Cameron.

[*Communicated by J. Cosmo Melvill, M.A., F.L.S.*]

Received and read December 13th, 1898.

The systematic position of Westwood's genus, *Trigonalys*, has been much discussed by writers on the group. St. Farjeau (*Hymén.* iii. 561) regarded its affinities as doubtful, but hinted at its having some relationship to *Tiphia.* That, however, it cannot be included in the aculeate section of the order is shown by its antennæ having more than thirteen joints, and by the trochanters being bi-articulate. By recent writers it has either been regarded as the type of a distinct family or as a tribe of the *Evaniidæ.* The latter is the view of the Rev. T. A. Marshall, who, in his *Cat. Brit. Hymen.*, p. 133, places the genus in the *Aulacides*, but it is not so included by Schletterer in his monograph of that group (*Ann. Hof-Mus. Wien*, 1889-90). Foerster (*Ueber den systemat. Werth des Flügelgeäders b. d. Hymen.*, 1877) treats it as a distinct family, in which he is followed by Cresson (*Trans. Amer. Entom. Soc.*, 1887, *Supp.*, p. 23).

The systematic position of *Trigonalys* is undoubtedly a difficult one, as is also the position of *Pelecinus*, *Stephanus*, and the Australian genus *Megelyra*, all of which stand out more or less isolated from the *Ichneumonidæ*, *Braconidæ* and, to a less extent perhaps, from the *Evaniidæ.*

In the *Trans. Entom. Soc.*, 1868, p. 328, Westwood

September 8th, 1899.

described a genus *Nomadina* from the Amazons, which he correctly regarded as nearly related to *Trigonalys*, and which is undoubtedly closely allied to the present genus. Both have a considerable likeness to a bee, as is indicated by the Westwood's choice of a name from the bee genus *Nomada*. The two genera may be separated as follows :—

Wings with four cubital cellules ; the third cubital cellule small, receiving the second recurrent nervure ; the first joint of the antennæ small. *Nomadina.*

Wings with three cubital cellules ; the third cubital cellule large, extending to the apex ; the second cellule receiving the recurrent nervure. *Liaba.*

These two genera then will be included in the family *Trigonalidæ*, which will now be divided into two tribes, the differences between them being best exhibited in synoptical form.

Antennæ at least 21-jointed ; head largely developed behind the eyes ; wings with three transverse cubital nervures ; the first recurrent nervure received in the second cubital cellule, which is much narrowed, if not petiolate, above ; the second abdominal segment larger than any of the others. *Trigonalidæ.*

Antennæ 16-jointed ; head not much developed behind the eyes ; wings with two or three transverse cubital nervures ; the first transverse cubital nervure received in the first cubital cellule ; the second cubital cellule not much narrowed above ; the abdominal segments not differing much in length. *Nomadinæ.*

Trigonalys has a wide distribution over the globe, but the species are few in number and, so far as I know, are rare in collections. In North America a few species are known. I have myself described six species from Central America, and species have also been recorded from South America. In Britain we have one species, *T. anglicana* Shuck.

The only record we have of the natural history of *Trigonalys* is a note by Smith (*Trans. Entom. Soc.*, i. (n.s.), p. 176), who states that he found a species in the nest of a *Polistes*. In connection with that observation, it is worthy of note that many of the species described have a considerable resemblance to wasps, while the species I now describe has a great resemblance to a bee, as has also *Nomadina*.

LIABA, *gen. nov.*

Antennæ not much longer than the head and thorax united, stout, placed immediately over the clypeus; the first joint large, cup-shaped; the second about one-fourth of the length of the first; the third and fourth joints about equal in length; the basal joints of the flagellum longer than broad; the apical broader than long. Head nearly as wide as the mesothorax, not much developed, and obliquely narrowed behind the eyes; occiput margined. Ocelli not quite forming a triangle. Clypeus small, its apex rounded. Mandibles large, broad, about as broad as long; its outer edge roundly curved, its inner half with three large, sharply triangular teeth. Eyes parallel, large, curved on the inner side, and distant from the base of the mandibles. Palpi apparently minute. Thorax of normal form; the parapsidal furrows deep, complete; scutellum not much raised; metathorax with a gradually rounded slope. Legs of moderate size; the trochanters with two joints; the tarsi stout; the patellæ distinctly developed; the claws bifid, minute. Wings with one radial and three cubital cellules; the radial cellule not reaching to the apex of the wing; the first cubital cellule is longer than the second; the third is the longest of the three; the cubital nervure issues from the transverse basal; the first recurrent nervure is received in the first cubital cellule, near the

first transverse cubital nervure; the second about the same distance from the second transverse cubital; the costal cellule is distinct; the first transverse cubital nervure is sharply, the second slightly, oblique; both are bullated below; the transverse median nervure is received on the outer side of the basal; there are two discoidal cellules, the upper being the longer and triangularly narrowed at the apex; the sub-discoidal nervure issues from shortly below the middle of the discoidal. In the hind wings the cubital nervure is obliterated beyond the transverse cubital; the discoidal is complete. The abdomen has seven segments; the first is triangular; the second is only slightly longer than the others; the basal two ventral segments are normal; the third in the middle projects into a large plate, which is broader than long, not much narrowed towards the apex; the fourth segment is depressed; the fifth is raised so that the plate on the third segment is on a level with its top; the apical two segments are turned down; the last or seventh has the apex roundly incised.

The front is furrowed down the middle; on either side, behind the ocelli, is a depression next to the raised occiput; the antennæ have a distinct pedicle; there is a narrow, but distinct, longitudinal furrow on the mesopleuræ; there is a similar narrow longitudinal furrow on the mesosternum.

LIABA BALTEATA, *sp nov.*

Flava 7 nigro-maculata; flagello antennarum rufo-testaceo; pedibus flavo-testaceis, femoribus nigro-maculatis; alis hyalinis; costa stigmateque flavo-testaceis. ♂.

Long. 7 mm.

Hab. Chili (Gervase F. Mathew, R.N.).

Antennæ stout, if anything thicker towards the apex;

the scape and second joint pallid yellow, covered with short, white hair; the basal joint of the flagellum blackish; the others rufo-testaceous. Head shining, impunctate, thickly covered with short, fuscous hair; the occiput, the ocellar region, an oblique line on the vertex extending from the eyes to the occiput, the oblique foveæ over the antennæ, the frontal furrow, and the top and sides of the clypeus, black; the mandibular teeth are piceous. Thorax yellow; a large mark on the middle lobe of the mesonotum rounded behind, the greater part of the lateral lobes, a large, somewhat pyriform, mark on the scutellum, a line on the apex of the scutellum extending to the wings, the apex of the postscutellum, the base of the median segment continued shortly outwardly inside the spiracles, a broad line narrowed in the middle on the propleuræ, the base and apex of the mesopleuræ in the middle, the middle furrow, the base of the metapleuræ, an oblique line in the middle, and the mesosternum, black. The front femora are in the middle, the four posterior more broadly, dark fuscous; the base of the coxæ and of the trochanters are black; the calcaria are minute, sharp; the tarsi are stout; the metatarsus not quite so long as the succeeding joints united; the middle joints sharply project at the apex. Abdomen smooth and shining; the base of the first segment black, the black produced at the sides and triangularly in the middle; the ventral segments are black at the base and apex.

Manchester Memoirs, Vol. xliii. (1899), *No.* **10.**

X. Experiments on the Relation between Uniform Stress and Permanent Strain in Annealed Copper Bars and Wires.

By George Wilson, M.Sc.
Demonstrator in the Whitworth Engineering Laboratory,
Owens College, Manchester.

Received and read March 21st, 1899.

The relation existing between the permanent set in an iron bar and the uniform longitudinal stress inducing it has been demonstrated experimentally by Dr. T. E. Stanton in a previous communication to this Society,* wherein it is shown that the stress varies as the fourth root of the strain.

The extension of these experiments, using annealed copper bars as described below, brings out the fact that in this case the stress, instead of varying as the fourth root, varies approximately as the square root of the strain, the index altering slightly according to the method of straining the bar.

In the experiments made by Dr. Stanton, each bar operated upon was rapidly subjected to a pre-arranged load. It was then allowed to stand under this load for a period of thirty minutes, after which it was removed from the machine and the diameter and extension measured.

Thus, by straining a sufficient number of bars, it was possible to obtain a series of points on the stress-strain curve. If, instead of the stresses and strains, the logarithms of these quantities are plotted, according to the method of

* *Manchester Memoirs*, vol. viii., 1893-4.

Professor Reynolds,* it is found that the points so obtained all lie upon a straight line, inclined to the axis at an angle whose tangent is ·25, thus indicating a relation of the form $f = Ce^n$, where f is the stress in tons per square inch of the reduced section of the bar, and e is the permanent strain and equals

(stretched length − original length)/original length,

C being a constant.

The object of using a separate bar for each point in the curve was to eliminate the time-effect of the previous loading, whilst the continuation of the loading for 30 minutes after its full value had been reached allowed the bar to complete its extension before measurement.

The stress-strain diagrams obtained in this manner will differ from those usually drawn by automatic recording instruments, inasmuch as the extension for a given load will be less in the latter case than in the former.

For the copper bars the law of extension has been obtained for both cases, viz., for the extension under a continuously-increasing load, with no period of rest; and, secondly, for bars loaded in a manner similar to that adopted for the iron specimens already described.

The copper bars used were 12 inches in length and $\frac{5}{8}$-inch diameter. They were cut from drawn copper rods, carefully annealed at the works of the manufacturers, Messrs. the Broughton Copper Company who kindly provided the bars, and were found to be sufficiently true to do away with the necessity of turning them to a particular size.

A length of $5\frac{1}{2}$ inches, and in some cases 6 inches, was set out upon a line scribed on each bar parallel to its longitudinal axis. The ends of this length were indicated by two small centre punch-marks, and into these the

* *Phil. Trans.*, 1879, p. 753.

points of the extensometer screws were placed, thus ensuring a correct attachment to the specimen.

This extensometer, which is shewn in *Fig. 1*, contained no multiplying arrangement, but simply afforded a means of reading easily the extensions after yield point, whilst the load was increasing.

It consisted of two tubes, the inner one of brass, coated with white paper upon which was drawn longitudinally a scale of inches and tenths, and an outer tube of glass, of such a diameter as to slide freely over the inner tube without too much side-play, and upon the inner surface of the glass a vernier was attached, which enabled the extensions to be read to the hundredth of an inch.

After the diameter of the bar had been carefully measured by a micrometer-gauge, the extensometer was attached and the whole placed in the testing machine. Upon the pressure being applied, readings of the extension were taken when certain pre-arranged loads were reached, and both load and extension were noted.

Six bars were tested in this manner, the second however being rejected owing to the extensometer becoming loose; with the remaining bars 24 points were obtained, for which the logarithms of stress and strain have been plotted, and are reproduced in *Fig. 2*.

The third bar of the series was carefully weighed before testing and its specific gravity obtained. This was found to be 8·917. After testing, a length was cut out of the centre, the specific gravity of which was 8·905. For the purposes of these experiments the density of the bars was therefore assumed to remain constant.

If P is the load, e the strain due to P, and A_0 the original area, then assuming constant density,

$$\text{stress on reduced section} = \frac{P}{A_0}(1 + e).$$

The values of e and $\frac{P}{A_o}(1+e)$ have been calculated for each bar, and are shewn in the appendix (Tables I. to V). The value of n has been obtained by finding the slope between each pair of points in the test and taking the mean of the results, and has also been checked graphically from the diagrams.

The corresponding values of C have been calculated from the assumed values of n, and are shewn below.

Test.	n.	C.
1	·535	38·08
3	·535	38·97
4	·503	36·165
5	·526	37·863
6	·519	37·470
Means.	·524	37·91

The relation is therefore $f = 37{\cdot}91 e^{\cdot 524}$.

The maximum variation of n from the mean value being 4% below and 2% above, whilst the corresponding variation in C is 4·6% below and 2·8% above.

If, instead of plotting a stress-strain curve for any bar, the extensions are plotted as abscissæ and the corresponding loads as ordinates, it will be found that, after the elastic limit is passed, the curve so obtained falls away from the straight line, the strains increasing much more rapidly than the loads. At some point in the curve the loads reach a maximum value, after which further extension is accompanied by a diminished load.

This maximum value of the load, when divided by the original area of the cross-section of the bar, is called the maximum stress, and it is simply stress per unit of original area instead of stress per unit of actual area.

If the formula $f = Ce^n$ represents the variation of actual stress with strain, then

$$f = \frac{Ce^n}{1 + e}$$

will give the corresponding stress per unit of original area.

By differentiation, the maximum value of this stress will occur when

$$e = \frac{n}{1 - n}.$$

For annealed copper this equals 1·101 when n is ·524, or 110 %, whilst the corresponding value for iron and steel (n = ·25) is $33\frac{1}{3}$ %.

The maximum stress for annealed copper should therefore be 18·98 tons per square inch of original area.

On testing a bar of the annealed copper cut from the same rod as the previous ones, the stress at yield point was found to be 2·23 tons per square inch, whilst the maximum stress was only 15·5 tons per square inch, with an elongation (by the formula) of 30·3 %.

In order to discover if the speed of the test could account for this difference between the theoretical and actual maximum stresses, a second bar, which was annealed in the Laboratory, was tested very slowly, when it was found that the maximum stress only amounted to 13·79 tons per square inch, whilst the elongation had risen to 49 % (measured).

This is only in accordance with the view expressed by Professor Ewing,* that metals such as copper show to greater advantage as regards breaking strength and less advantage as regards elongation the greater the speed of the test.

Further, as the first of these two tests was made at approximately the same speed as those from which the

* *Proc. R. S.*, vol. xxx., p. 510.

law was obtained, it is evident that the difference cannot be due to variation in speed.

On referring to the Records of tests made for the public in the Whitworth Laboratory, to see if a stress of 19 tons per square inch had been obtained, the highest recorded stress for annealed copper rods was found to be 16·97 tons per square inch, with a corresponding measured elongation of nearly $37\frac{1}{2}$ %. This bar curiously happened to come from the same makers as the bars in question, and the results obtained from it correspond very fairly with the above formula, the theoretical stress for an elongation of $37\frac{1}{2}$ % being 16·5 tons per square inch.

It is evident, therefore, that the annealed copper and iron both refuse to follow the law any further when the elongation has reached a certain value, about 33% for iron and between 30% and 40% for the copper.

In the case of the iron this occurs after the theoretical maximum load has been passed, thus enabling the theoretical maximum stress to coincide with the actual maximum stress as determined from experiment, whilst for the copper the theoretical elongation is never reached, and hence the maximum stress from experiment is less than its theoretical value.

To eliminate the time-effect of the load on the extensions, a set of bars were loaded in turn to pre-arranged amounts, each bar being allowed to stand under its load for 30 minutes and being then removed from the machine. This ensured that the viscous extension might have time to cease before measurement.

After the 30 minutes' interval the extension had practically ceased, and each bar was removed and measured. The result of these tests are shown in the appendix. (Tests 7–15; tests 13, 14, 15 being repetitions of Nos. 7, 8, and 12).

The logarithmic plotting is shown in *Fig.* 2, the points obtained being indicated by the circles.

The mean value of n is ·512 with a corresponding value of $C = 40{\cdot}25$.

In finding n, only those points which lie on the line have been used; with respect to the points Nos. 8, 13, 15, an error of ·01 inch in measuring the extension would account for their variation from the mean line. Thus the formula becomes $f = 40{\cdot}25 e^{\cdot 512}$.

In the expression $f = Ce^n$, C represents the stress which will extend the bar to twice its original length. If n be put equal to unity then the law represents the elastic extension, C having a different value, viz., the modulus of direct elasticity, but still being the stress necessary to double the length of the bar.

The result of plotting the logarithmic stress-strain curve for the elastic portion would evidently be a straight line inclined at 45° to the axes of coordinates. The point of intersection of this line with that previously obtained would mark the yield-point.

Being desirous of obtaining a complete diagram before and after the yield-point, and not possessing the means of measuring the elastic extensions of the $\frac{5}{8}$-inch diameter bars, a series of copper wires were tested up to a stress somewhat beyond the elastic limit.

These wires, which finally were cut in lengths of about 20 inches, were suspended vertically and loaded by weights applied to the lower end of the wires by means of a hanger. On the under side of the hanger was a projection, which could be brought into contact with the upper end of a vertical screw working in a nut attached to a disc divided circumferentially into 100 equal parts. The screw was chased with 10 threads to the inch, so that extension of ·001 inch could be measured, and of ·0001 inch estimated.

Each wire, after fixing, was stretched by loading the hanger until permanent set took place, and then carefully annealed whilst in position by means of a blowpipe.

This stretching and annealing was repeated until the wire was apparently free from kinks and bends, after which the length and diameter were measured and the test commenced.

The increment of load varied from $\frac{1}{2}$lb. to 2lbs., and, as each successive load was applied to the hanger, the wire extended, and when the extension had apparently ceased, the reading was taken. As the tests each occupied some hours, any change in the temperature of the laboratory was noted and allowed for in reducing the results.

Again, as it was impossible to measure directly the extension of the wire due to the weight of the hanger, this extension was estimated by considering the elastic portion of the wire and exterpolating accordingly.

After the test was concluded the wire was re-annealed and stretched several times, and then re-tested in the above manner. One wire was tested five times in this way, altogether corresponding to 8 stretchings.

The results shown in the form of the logarithmic stress-strain curve in *Fig. 3* are those of the last wire tested, and they may be taken as characteristic of the other wires which were examined.

The curves there shown have the strains for abscissae and the quantity $P(1+e)$ for ordinates.

To obtain the actual stress it is necessary to divide by the original area of the cross section of the wire. To measure this area for each additional load would be difficult, hence the assumption of constant density was again made, and the areas required were calculated from the data afforded by the original volume and the change in length. In order to show that this assumption was

justifiable the specific gravity of a length of unstrained wire was determined. This was found to be 8·918. Coincidently a length of wire was tested with a load of 30lbs. and annealed, this being repeated three times. Its specific gravity was then found to be 8·905, the alteration in stress due to this would be ·14 %. Returning to the wires, it will be noticed that in the first test plotted there are irregularities in the elastic portion, and further that the yield-point is not definite, as the elastic portion begins to curve away, and finally settles down into a straight line inclined to the axis at an angle whose tangent is ·273. The elastic limit is reached soon after the eighth point on the curve, and the yield-stress is certainly not lower than 1·22 tons per square inch.

After annealing, stretching, and re-annealing, the wire was again tested. The irregularities previously observed in the elastic portion of the curve were still repeated though in a less degree, as can be seen from the diagrams. The final value of n has risen to ·423, and the elastic limit though still slightly indefinite has been taken to occur at the seventh point on the curve. This corresponds to a yield-stress of 1·11 tons per square inch.

The wire was now annealed and retested. It will now be noticed that the irregularities in the elastic part have disappeared, and that the points form two straight lines. The value of n is ·413, and the elastic limit, which is now quite definite, is at the fourth point, corresponding to a yield-stress of ·715 tons per square inch.

Unfortunately the test of this wire was carried no further, but the lowering of the yield-stress and the gradual smoothing out of the curve are characteristics which appeared in the wires tested previously to this.

Thus, as far as the experiments were carried, repeated annealing and straining besides rendering the wire more

homogeneous, have the effect of lowering the yield-stress and increasing the value of n, though how far the lowering of the elastic limit would continue with further strainings the author has not determined.

In this respect, however, the copper wires exhibit a marked difference from the iron and steel bars tested by Professor Unwin, who found that neither the elastic limit nor the second part of the load-strain curve was altered by repeated straining and annealing.

The tests of bars and wires described above were made on the testing machine and apparatus in the Whitworth Engineering Laboratory, The Owens College.

APPENDIX.

TEST No. I.

ANNEALED COPPER SPECIMEN.

Initial length 6″, Initial diameter ·625″, Area ·3068 sq. in., Value of $n = {\cdot}535$.

Load, P tons.	Strain $e=\frac{\alpha}{l}$	Stress $\frac{P}{A_0}\left(1+\frac{\alpha}{l}\right)$ (tons per sq. in.)	Value of C (Calculated).
2·0	·04	6·78	37·94
2·5	·0625	8·658	38·16
3·0	·0917	10·675	38·33
3·5	·1342	12·939	37·89
		Mean value of C	= 38·08

Test No. III.

ANNEALED COPPER SPECIMEN.

Initial length $5\frac{1}{2}''$, Initial diameter ·622″, Area ·3039 sq. in., Value of $n = \cdot 535$.

Load P in tons.	Strain $e=\frac{\alpha}{l}$	Stress $\frac{P}{A_0}\left(1+\frac{\alpha}{l}\right)$ (tons per sq. in.)	Value of C (Calculated).
1·5	·0218	5·043	39·05
2·0	·0382	6·833	39·19
2·5	·0618	8·735	38·73
3·0	·0891	10·751	39·20
3·5	·1309	13·024	38·69
		Mean value of C =	38·97

Test No. IV.

ANNEALED COPPER SPECIMEN.

Initial length 5·5″, Initial diameter ·622, Area ·3039. Value of $n = \cdot 503$.

Load P tons.	Strain $e=\frac{\alpha}{l}$	Stress $\frac{P}{A_0}\left(1+\frac{\alpha}{l}\right)$ (tons per sq. in.)	Value of C (Calculated).
1·5	·02	5·034	36·016
2·0	·0364	6·821	36·109
2·5	·0582	8·705	36·393
3·0	·0891	10·751	36·280
3·5	·1327	13·045	36·028
		Mean value of C =	36·165

TEST NO. V.

ANNEALED COPPER SPECIMEN.

Initial length 5·5″, Initial diameter ·622, Area ·3039.
Value of $n = ·526$.

Load P tons.	Strain $e=\frac{\alpha}{l}$	Stress $\frac{P}{A_0}\left(1+\frac{\alpha}{l}\right)$ (tons per sq. in.)	Value of C (Calculated).
1·5	·0218	5·043	37·728
2·0	·0382	6·832	38·053
2·5	·0618	8·735	37·775
3·0	·0909	10·769	38·017
3·5	·1327	13·045	37·742
		Mean value of C	= 37·863

TEST NO. VI.

ANNEALED COPPER SPECIMEN.

Initial length 5·5″, Initial diameter ·622, Area ·3039.
Value of $n = ·519$.

Load P (tons).	Strain $\left(e=\frac{\alpha}{l}\right)$	Stress $\frac{P}{A_0}\left(1+\frac{\alpha}{l}\right)$ (tons per sq. in.)	Value of C calculated.
1·5	·0209	5·039	37·514
2·0	·0382	6·832	37·193
2·5	·0600	8·720	37·554
3·0	·0882	10·742	37·878
3·5	·1327	13·045	37·211
		Mean value of C	= 37·470

Tests Nos. VII.—XV.

ANNEALED COPPER SPECIMENS.

Initial lengths 6″, initial diameters ·622″, areas ·3039 sq. in.

No. of Specimen.	Load P (tons).	Strain e.	Final diam. (ins.).	Final area (sq. ins.)	Stress tons per sq. in. on reduced area.	n.	C.	Remarks.
7	1·545	·01467	·619	·3009	5·134	...	...	omitted, not on line.
8	2·030	·0333	·612	·2942	6·901	...	...	,, ,,
9	2·515	·04967	·609	·2913	8·634	·512	40·162	
10	3·02	·0733	·603	·2856	10·574	·512	40·292	
11	3·525	·1067	·592	·2753	12·804	·512	40·265	
12	4·015	·1600	·579	·2633	15·249	...	...	,, ,,
13	1·525	·01583	·6202	·3019	5·051	...	...	,, ,,
14	2·02	·03133	·6135	·2955	6·836	·512	40·260	
15	4·01	·16716	·578	·2624	15·282	...	...	,, ,,
					Means	·512	40·25	

THREE TESTS OF COPPER WIRE.

	3rd Time.		5th Time.		6th Time.	
P	α	$P\left(1+\frac{\alpha}{l}\right)$	α	$P\left(1+\frac{\alpha}{l}\right)$	α	$P\left(1+\frac{\alpha}{l}\right)$
.175	·00017	·175	·00032	·175	·00024	·175
1·169	·00027	1·169	·00092	1·169	·00179	1·1691
2·164	·00142	2·164	·00402	2·1645	·00306	2·1643
2·660	·00247	2·660	·00474	2·6607	·00379	2·6605
3·156	·00307	3·1565	·00519	3·1569	·00489	3·1568
3·652	·00349	3·6527	·00609	3·6532	·00711	3·6534
4·148	·00355	4·1488	·00752	4·1496	·00844	4·1498
4·645	·00460	4·6461	·00967	4·6473	·01108	4·6477
5·640	·00578	5·6417	·01517	5·6445	·01773	5·6452
6·635	·00741	6·6376	·02177	6·6425	·02713	6·6444
7·629	·00941	7.6328	·02987	7·6409	·03696	7·6437
9·630	·01956	9·6400	·05131	9·6558	·07516	9·6676
11·630	·04262	11·6564	·07989	11·6785	·12336	11·7046
13·628	·07856	13·6852	·12675	13·7182	·18330	13·7580
15·622	·12490	15·7262	...	...	·25941	15·8327
17·620	·18125	17·7904	...	...	·33949	17·9310
19·618	·24824	19·8781	...	...	·43239	20·0590
Orig. length	18·72″		19·14″		19·23″	
Area	·001706 sq. in.		·001669 sq. in.		·001661 sq. in.	

NOTE.

The Broughton Copper Company having kindly offered to undertake an analysis of the copper bars used in the preceding experiments, a piece was cut from one of the specimens and forwarded them with the following result.

Analysis of B.S. Copper:

Copper	99·74	per cent.
Arsenic	·024	,,
Lead	·130	,,
Bismuth	·007	,,
Nickel	trace	
Antimony	nil	
Oxygen (by diff.)	·099	,,

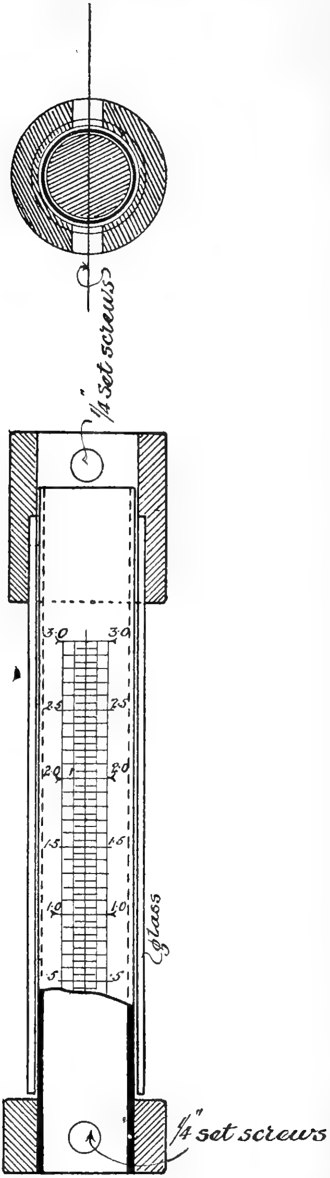

FIG. 1

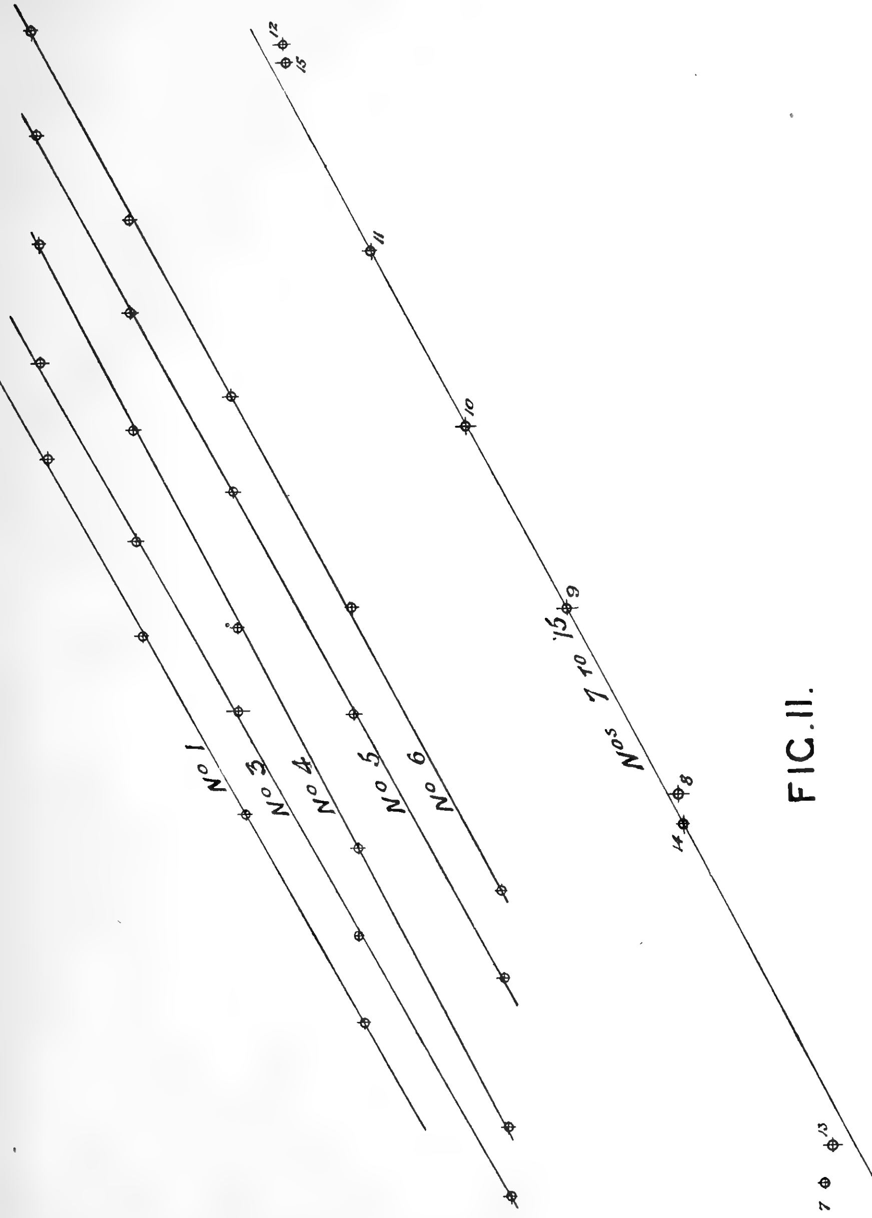

FIG. II.

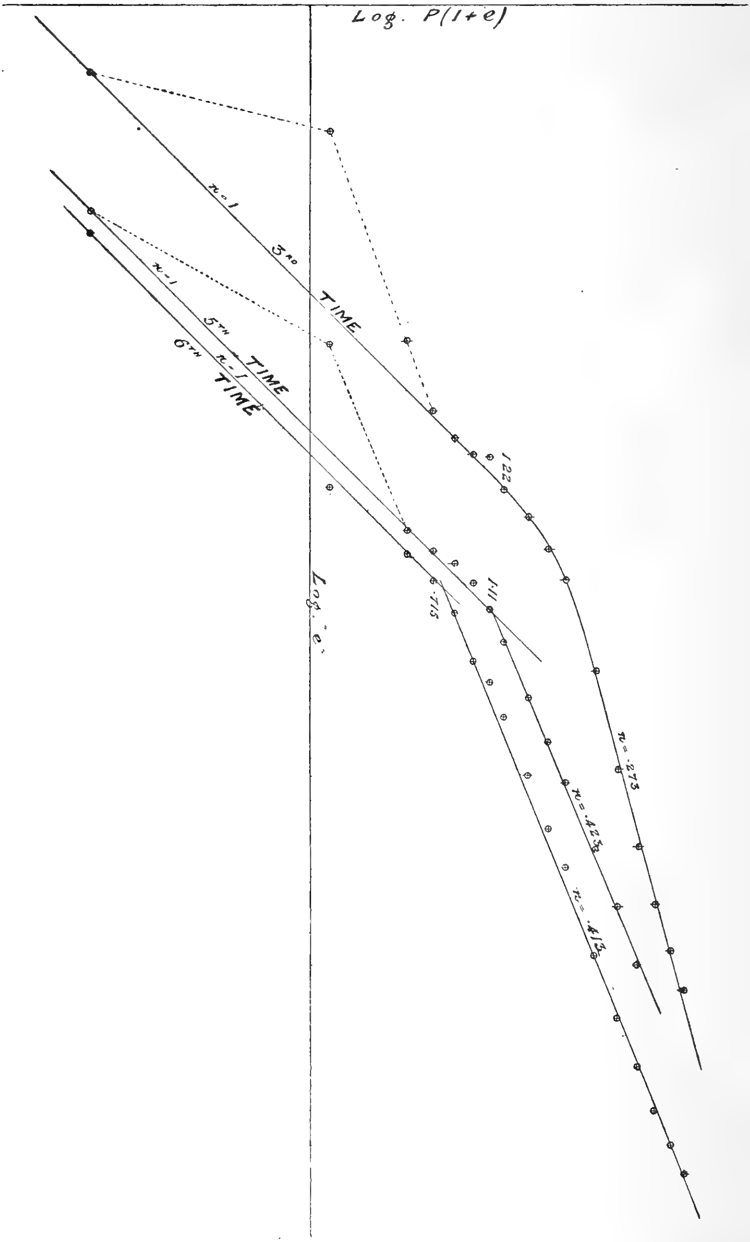
Log. P(1+e)
Log. "e"
n=1
3RD TIME
n=1
5TH TIME
n=1
6TH TIME
1.22
1.11
.715
n = .273
n = .423
n = .413

FIG. III.

XI. On Calinaga, the Single Genus of an aberrant Sub-Family of Butterflies.

By JOHN WATSON.

[*Communicated by J. Cosmo Melvill, M.A.*]

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In the catalogue of Lepidoptera in the East India Company's Museum (pl. 3a, fig. 5.), Mr. Frederick Moore described from Sikkim a male butterfly, placing it in the family *Nymphalidæ*, giving the species, which was described from a single specimen, generic rank under the name of *Calinaga Buddha.* Subsequently, in 1871, Mr. Kirby in his "Synonymic Catalogue of Diurnal Lepidoptera" placed it in the *Papilionidæ* as the second genus, which position was in the "Supplement" (published 1877) altered to the *Nymphalinæ* just after *Euripus*, *Hestina* and *Hypolymnas.* Later again, Mr. Charles Oberthür of Rennes in "Études d'Entomologie" Livr. VI., p. 11, pl. 8, fig. 6, ♂ (1881), described and figured from Thibet a pale form of *Buddha* to which the specific name of *Davidis* was given, erroneously I think as a specific designation, for from various parts of Thibet and Western China I have a series of this sub-species which runs insensibly into typical *Buddha ;* so closely, indeed, in some specimens that if the locality-labels were removed it would be hard to determine with certainty which was *Buddha* and which *Davidis.* In *Trans. Entom. Soc.*, 1893, p. 121, Mr. Melvill described from upper Siam the finest species of the genus, *C. Sudassana*, the type specimen of which is now in Mr. C. H.

Schill's collection. Another of the three known specimens of this beautiful species is in Mr. Hastings C. Dent's collection. Mr. A. G. Butler described the ♀ of a *Calinaga* giving it specific rank under the name of *Brahma* and, from a careful examination of this rare ♀ and those of *Davidis*, also scarce, Mr. F. Moore removed the genus from the Nymphalid sub-family *Nymphalinæ* (where as I have before mentioned it was placed by Kirby, and again by Schatz in the *Diademen-gruppe* along with the three previous mentioned genera) and in "Lepidoptera Indica" (Vol. II., p. 221) founded a new sub-family of the *Nymphalidæ* to receive this genus, which consisted at the most of three and probably only of two species. In the *Entomologist* (Vol. 27, p. 100) Mr. W. F. Kirby in a most interesting article on *Mesapia* says "Oberthür (Études d'Entom., IV., p. 19, pl. II., fig. I.) describes under the *Papilionidæ*, a new genus and species from North China, which he calls *Davidina Armandii*, and which he places between *Calinaga* (now recognised as belonging to the *Nymphalidæ*) and *Parnassius*" thus Oberthür evidently included *Calinaga* in the *Papilionidæ* along with *Parnassius* and *Davidina*.

It will thus be seen that there exists an amount of uncertainty as to where this most curious genus of butterflies should be placed, and it was with this uncertainty in my mind that I commenced to work out the morphology of the exoskeleton of the genus, and I now am pleased to be able to lay the result before you. The work has been costly; so much so, indeed, that on this account I had been tempted to abandon it, till I received most valuable assistance from M. Charles Oberthür of Rennes, and the Hon. Walter Rothschild of Tring, who kindly placed at my disposal a number of their duplicates of rare genera which I wished to examine, and which I should perhaps

not otherwise have seen. I have prepared and examined over 600 microscopical slides from these specimens, a few of which I have photographed in order to show important characters which refer specially to the genus under discussion.

In placing before you the chief results of my examination, I may confess at the outset that the evidence is incomplete, as in certain cases much more might have been done in investigating the intimate structure of the exoskeleton, particularly in regard to the Pierine genera *Baltia*, *Mesapia* and *Davidina* (which was placed as a Papilionine genus), and which, owing to their rarity, I have been unable to obtain. In our present knowledge of the genera mentioned, some of the results are confusing, and will, I think, remain so, until a much larger quantity of material is worked out and the results of the comparison of these genera, along perhaps with the investigation of the early stages of their metamorphosis, have been tabulated.

In dealing with the subject I have thought it advisable to divide my arguments into separate headings :

The evidence of geographical distribution.

The evidence of the structure of the egg shell.

The evidence of the structure of the legs.

The evidence of the structure of the antennæ.

The evidence of the structure of the basal cell of the hind wings.

The evidence of the general neuration and facies.

The Evidence of Geographical Distribution.

The habitat of the genus *Calinaga* is the Eastern portion of the Himalayan chain (*Buddha*), Yunnan, Western China and Eastern Thibet (*Davidis*), and Upper

Siam (*Sudassana*), the three districts being on the south-east borders of Thibet, and *Davidis* at least penetrates that highly elevated plateau whose lowest valleys are at least 12,000 feet above sea-level; one would thus expect the whole of the habitat, on account of its great altitude, to be inhabitated by forms of lepidopterous insects which might exhibit to us types of very old derivation from the original phylum, relics of an ancient lepidopterous fauna.

The first points which struck me in working out the Calinaga habitat were that the species are found contiguous to or in Thibet; and that in the various directions radiating from and including Thibet, there are a number of genera which possess well-marked characters belonging to the sub-families—*Pierinæ*, *Thaidinæ*, *Parnassiinæ* and *Leptocircinæ*—and especially that they all possess in common one character, namely, that they are mostly monotypic and rarely bispecific, and only in two cases are there three species to the genus.

The following list will indicate the point:—

Sub-family.	*Genus.*	
Pierinæ;	*Mesapia*,	One species, Tartary and N.E. Thibet.
	Baltia,	Two species, E. Turkestan, and N. W. Himalayas.
	Davidina,	One species, N. China.
Leptocircinæ;	*Leptocircus*,*	Two or three species, Indo-Malayan and West China. The species from West China (*Meges*) having simple claws, and the Javan species having double ones, as is found in *Pierinæ*.

* *Leptocircus* might truly be referred to as two genera, possibly this will ultimately be done.

Sub-family.	*Genus.*	
Thaidinæ;	*Luehdorfia,*	Two species, Siberia and Japan.
	Teinopalpus,	One species, Assam and Thibet Border.
	Bhutanitis,	One species, Bhutan and Thibet Border.
	Armandia,	One species, W. China and E. Thibet.
	Doritis,	One species, Turkestan, Syria.
	Ismene,	One species, Turkestan.

Now what is the import of this remarkable fact of the occurrence in or on the borders of one district of great altitude, of a number of genera of only monotypic or bispecific rank? In the first place it leads one to think that they are genera whose evolution is in a transitory stage, or else, as is more probably the case, they are the representatives handed down to-day as archaic types of genera which segregated in distant, perhaps even glacial times. Let us see by analogy if this theory can be supported by facts; for, if so, the first part of understanding the phylogeny of *Calinaga* will be much simpler.

One of the most interesting papers I have read on phylogeny is that of Dr. F. A. Dixey on the "Phylogeny of the Pierinæ" (*Trans. Entom. Soc.*, 1894), where in discussing the evidence of their distribution, he says, regarding the oldest form of Pierine *Schatzia* (*Eucheira*) *socialis*: "Its nearest allies appear to be Behr's two species of *Neophasia* which inhabit the same region with itself, and the *Pontias* and *Metaporias* of the high lands of Central Asia, most of which forms are known to retain the ancient larval habit of spinning. These facts seem to point to the conclusion that *Eucheira* is the relic of an archaic group of Pierines which once occupied the great mountain

regions of both the Palearctic and Nearctic continents, and whose immediate descendants, still represented in the East by *Metaporia* and *Pontia* have in the West become extinct (unless Behr's *Neophasia* be a survival), after giving origin to the group of genera headed by *Catasticta*"; and again (*Loc. cit.*, p. 323) he says: "Turning now to the Eastern *Metaporias* which inhabits the borderland between the Palearctic and Oriental regions, we find it emitting one clearly-defined branch in the Palearctic direction. This is the branch to which belong the various species of *Pontia*, as *P. Nabellica*, *Hippia*, *Soracta*, *Belucha*, *Leucodice*, and *Cratægi*." In these remarks we thus have evidence that the high lands of Central Asia (the home of the peculiar monotypic genera before-mentioned) form a locality in which we might reasonably expect to find some ancient types of lepidopterous fauna. That it is in highly-elevated regions generally or in regions which, though their altitude is much lower, nevertheless agree with them in an isothermal sense and in the length of their summer, that these ancestral forms of butterflies are most likely to be found, there is very abundant proof in Weissman's *Studies in the Theory of Descent*, "On the seasonal dimorphism of butterflies," where he states, in discussing the parent form of our common *Pieris Napi* (var. *Bryonæ*), a very dark-veined form which is found in the higher alps of Europe, in Lapland at low elevations, and in Alaska at sea-level. "In both regions (meaning polar regions and higher alps) *Bryonæ* produces but one generation in the year, and thus, according to my theory, must be regarded as the parent form of *Pieris Napi*." His subsequent temperature experiments amply confirmed his theory. In Thibet we also get some very dark forms of Pierids, closely allied to *Bryonæ*, one of which, in Oberthür's opinion has enough claim to be

specifically designated *P. Dubernardi* Oberthür (*Études d'Entom.*, Livr. IX., pl. 1, fig. 6), and another form is described (*Bull. Moscow*, 1890, pl. 8, fig. *a*) as *P.* var. *Intermedius.* Numerous other cases could be adduced, as in the genus *Aporia*,* but enough has been said to emphasise the fact that Thibet and the surrounding regions form a habitat for ancient types of butterflies, and it is most probable also, on this account, that *Calinaga* is the representative of one of the earlier genera which existed there in more remote times.

To summarise:—*Calinaga*, as deduced from the study of its geographical distribution, is an ancient derivate from the original phylum of Butterflies.

The Evidence of Form and Structure of the Egg Shell.

There is not much to be said on this point, as the ova of so many species of butterflies are unknown. I have not been able to get access to many exotic butterfly ova, and what I have critically compared have been obtained by maceration of the ♀ bodies in water, and teasing out the ova from the mass and mounting the whole. I have been fortunate enough in the case of *Calinaga Davidis* to get the micropyle intact, and in another case to get at least the upper half of an egg showing the longitudinal ribs.

The ova of the different families of butterflies present various forms in the various groups. Those of *Parnassius*, *Thais*, and *Teinopalpus* are round, wider than high, with a fine granular surface, the centre of each granulation is raised outwards and beautifully shown in *P. Imperator;*

* In the genus *Aporia* (*Pontia.* Dixey, *Trans. Entom. Soc.*, 1894), the Western China and Thibetan species, *Bieti*, *Oberthuri* and *Acrea* are the darkest species, whilst *Hippia*, which is also found in Turkestan, and *Cratægi*, from Europe and also from Japan and China, are the palest marked of all.

there are no longitudinal or horizontal ribs, nor raised lines. *Thais* and *Teinopalpus* have less pronounced granulations. In the *Nymphalidæ*, *Danais* and *Hestia* (of the sub-family *Danainæ*) have a more or less sugar-loaf shaped egg, half as high again as wide, with a series of very regularly placed, raised, longitudinal ribs from which, at regular distances, other finer ones run out horizontally, and so circle round the egg. The shell thus has the appearance of rectangular reticulations very evenly disposed. *Hestia* has more symmetrical and more transparent intercostal spaces, the term I give to the area between the ribs.

There is a similarity of these Danaine eggs to those of *Pieris* in general shape and structure, as will be seen by comparing *P. Brassica* with the figure of *Danais archippus* in Packard's "Text-Book of Entomology," (p. 521, fig. 496).

In the *Nymphalinæ*, another sub-family of the *Nymphalidæ*, we get another type of egg; for those of *Hypolymnas Salamacis*, *Bolina*, and *Anthedon* are round, squat, not so high as wide, resting on a flat base from which rise 10—12 longitudinal ribs, which terminate abruptly near the top, leaving a bare, almost structureless, area, in the centre of which is the micropyle. There are apparently no transverse ribs, the shell is of delicate and extremely transparent texture. This egg agrees in general characters with that of the British butterfly *Hipparchia Tithonus* (Westwood's Brit. Butt., pl. B, fig. 29). *Hipparchia* is one of the *Satyrinae*, another sub-family of the *Nymphalidæ*. The egg of *Calinaga* is apparently of a similar shape and structure, but it has not perhaps the perfect symmetry of *Danais* and *Hestia;* it is not quite so tall, and the intercostal spaces at the top, which are very unequal, remind one perhaps of a *Pieris* as for

instance, *Synchloe Sisymbryi* (Edward's Butterflies of North America, Pieris, pl. I., fig. A3).

The evidence of the egg, meagre and incomplete though it be, removes *Calinaga* from the *Hypolymnas* section of *Nymphalidæ* and from *Parnassius*, and places it nearer to *Hestia* and *Danais*.

THE EVIDENCE OF STRUCTURE OF THE LEGS.

Probably the most important point in the histology of this genus is to be found in the structure of the tarsi of the forelegs of the ♀, and in evidence of this I cannot do better than quote from Mr. Moore's MSS. notes, made March, 1895, and of which he has been kind enough to give me a written copy, from which the following is an extract:

"Note on *Calinaga*, made March, 1895.

Forelegs of male, pectoral; femur, tibia, and tarsus clothed with fine, long hairs; tarsus ⅔ the length of tibia, unarmed. Forelegs of female, somewhat longer and more slender, much less hairy, the hairs shorter and finer, especially on tibia and tarsus, which are much shorter and bristly; the tarsus thicker, five-jointed, the first joint nearly as long as the other four altogether, the fifth as long as the third and fourth together, the latter each with a short, lateral, very fine and delicate spine, and the terminal joint armed with a pair of rather long, prominent, stout, curved, forward-projecting claws, these claws being very closely approximate at their base; below these claws is a pair of paronychia and pulvilli."

And again (*Lepidoptera Indica*, vol. II., p. 221):

"In *Calinaga*, a genus hitherto placed in the *Nymphalinæ*, the female of both the Indian and Chinese species has the foretarsus perfect, the terminal

joint being furnished with a pair of rather long, stout curved, forward-projecting claws, paronychia, and pulvilli. This genus we have assigned to a subsequent sub-family, the *Calinaginæ*."

It is thus seen that on this one character, the perfect forelegs of the female, the genus was raised to the rank of a sub-family. There is one other genus, *Pseudergolis*, which is in the *Nymphalinæ*, in which the female sex possesses claws and paronychia on the forelegs; this is, without doubt, also an aberrant genus, but it is an exception to *Calinaga* in this respect, that its position in point of general resemblance and neuration is undoubtedly in the *Precis* and *Junonia* section of the *Nymphalinæ*.

The fact that *Calinaga* possesses paronychia—lateral flaps of toughish membrane which extend forwards from the under side of the anterior end of the last tarsus, just below the claws; and also possesses a pulvillus or pad, situate between the paronychia and under the claws, is important, and its full import will be apparent when other groups of Lepidoptera, and indeed other orders of insects, are investigated for information on these points.

Amongst Lepidoptera these paronychia, pulvilli and claws are fairly numerous. On the middle and hinder legs of both sexes in the family *Nymphalidæ* they are general, but in no case on the forelegs of the male, and only in *Calinaga* and *Pseudergolis* are they found on the foreleg of the female. For one of the finest types of this structure we must look amongst Butterflies to the family *Pieridæ*; and in the sub-family *Pierinæ* they are found on all legs of both sexes, the claws however are bifid. In another sub-family, the *Callidryinæ*, certain genera, *Gonepteryx* as an instance, have no paronychia or pulvilli on the foreleg of the female, but only on the middle and hind legs, thus indicating a stage of development approxi-

mating to that of *Nymphalidae*. In the *Papilionidae* proper, all the legs of both sexes are furnished with stout simple claws, but with no paronychia or pulvilli. Amongst the moths there are also genera which are furnished with paronychia; *Platiamisa* a Nearctic genus, will serve as an illustration.

If we go into the examination of other insect orders, we find these paronychia and pulvilli in Hymenoptera, Diptera, &c. The honey bee is a good type, and in most orders of insects they are developed, often differing only in detail from those of the Lepidoptera.

It is generally assumed that the possession of these structures is for the purpose of adhering to smooth surfaces, as the claws are for attachment to rough. Packard discusses the mechanism of insect locomotion, and gives figures from Cheshire's "Bees and Beekeeping," in "The Text-book of Entomology" (pp. 114 to 116, *Figs.* 105, 106, and 135), particularly illustrating the methods of application of these structures to rough and smooth surfaces.

The significance of the occurrence in other orders of insects of these accessory tarsal structures is that we have here in *Pierinæ* and *Calinaginæ* a development of very ancient character, as it is not likely that these structures would be developed independently of each other in the various orders of insects in which they are found. The logical conclusion is therefore that they are characteristic developments of the whole insect phylum, specialised in certain cases, degenerated and rudimentary in others, and obsolete in the *Papilionidæ*, &c.

It is also well known that the female sex is more conservative in the retention of ancestral characters than the male, and thus is explained the fact why it is the male sex which has lost (as in *Nymphalidæ* generally) the

claws and other tarsal structures more completely than the female; for, although *Danais*, *Hestia*, *Amauris*, &c., in the *Danainæ*, and *Hypolymnas*, *Hestina*, &c., in the *Nymphalinæ* have the tarsi developed in the female and not the male, they are nevertheless almost abortive, and in a degenerated stage generally, and the whole foreleg is weak.

Thus the female *Calinaga* shews in its tarsal structure the most ancient type of leg of the whole of the *Nymphalidæ*, and illustrates the stage of formation just before the family lost these important structures.

With the adaptation of butterflies to an arborescent habitat (which according to some indicates a higher type of development) came the loss, evidently by atrophy, of the disused tarsal appendages and first we get a type, as in *Papilio*, where the claws persist, and a later and higher developed stage, as in typical female *Danais*, where the tarsi are abortive and the appendages are obsolete, and the most pronounced of all is say a typical male *Danais*, where the ultimate tarsi are entirely wanting, and the whole leg weak, and shewing an approaching atrophism.

THE EVIDENCE OF ANTENNAL STRUCTURE.

This is a point in the histology of the genus to which I have been unable to give the attention I desired; but I will briefly state the comparison of the form.

The general form of antenna is more like that of *Euplœa* and *Danais* than that of any other genus I have investigated; the shaft is rather stout, swelling gradually to the club. It is on this account unlike *Hestia*, which has a well-defined club, and still more unlike *Hypolymnas*, which has a most pronounced club. In this respect also *Calinaga* is unlike *Parnassius*, and most unlike the sub-

family *Pierinae*, which are generally very markedly clubbed. So much for general form.

In a splendid article by Dr. Karl Jordan, "Contributions to the Morphology of Lepidoptera, I. The Antennæ of Butterflies" (*Nov. Zool., Vol. V., August, 1898*), dealing with their structure in a manner impossible to me (p. 386), referring to the sub-family *Calinaginæ*, says: "The scaling is confined to the dorsal side of the proximal joints. The scales are very narrow, resembling those of *Luehdorfia* and certain *Parnassius* (*stubbendorfi*)."

Now, if the scales of *Lepidoptera* have been derived from hairs such as are now found in *Trichoptera*, and such as, according to Jordan (*loc. cit.*, p. 400), the antennæ of the *Hepialidae* are furnished with, then perhaps we have evidence of microscopic histology which would lead one to infer that *Calinaga*, having very narrow scales on the antennæ in a transitory stage towards the ancient derivate of lepidopterous antennæ, is in unison with *Luehdorfia* and certain *Parnassius.*

Thus, in general form, *Calinaga* is similar to *Danais* and *Euplœa*, and in scaling like *Parnassiinæ.*

The Evidence of the Structure of the Basal Cell.

The basal cell of the hind wings of butterflies is a small structure formed at the base of the wings in certain genera by the peculiar conformation of the costal, subcostal and median nervures in conjunction with another which I term the "interno-costal nervule" and in its fullest developed form (as seen in *Papilio zalmoxis* or *Eurycus cressida*) is of a diamond-shaped form. I take *P. zalmoxis* as the type and for reference I have named the 4 limbs of the basal cell (its 4 boundary walls as it were) by the following terms.

I. The first part of the costal nervure from its origin at the base of the wing up to its emission of the precostal nervule I term the *antecostal* limb.

II. The basal portion of the subcostal up to the emission of the short spur which in reality closes in the basal cell (as the discocellulars close the discal cell) I term the *medio-costal.* It is generally weaker than the antecostal limb.

III. The short length or spur between the costal and sub-costal I term the *interno-costal* limb. It is generally the weakest part of the basal cell.

IV. The other stretch of nervure between the pre-costal and the costal proper (in reality of course a part of the costal) I term the *disto-costal* limb.

And it is the relative length and strength of these four limbs which give all the character to the size and shape of the basal cell. Now while the disto- and the ante-costal are generally well formed, the medio- and interno-costal are weaker. In *Papilio zalmoxis* and *Eurycus cressida* they are of equal value; thus a well-formed, diamond-shaped basal cell. But in *Danais*, *Hestia* and other allied genera, the ante- and medio-costals are long and lie in apposition, whilst the disto- and interno-costal are so very short that there appears to be no basal cell at all, and only on careful examination is it made out; whilst, as perhaps its antithesis, *Papilio montezuma* has an extremely short medio-costal and the interno-costal is as long as the disto- and ante-costals together.

In those cases where there is no basal cell at all, as *Hypolymnas*, *Aporia*, *Pieris* and others, it is because there is no interno-costal.

The extreme value of the study of the morphology of the basal cell is only apparent when large numbers of butterflies are systematically examined, and their relation-

ship, as evidenced by the degrees of development attained, carefully investigated and compared with other characters. I will illustrate my meaning by one case only before I proceed to investigate carefully the case of Calinaga.

In the Indo-Malayan region, in Sikkim for instance, is to be found a well marked genus of the *Papilionidæ*, the representatives of which, being nauseous, are mimicked by those of a similarly marked but morphologically widely separated genus. In certain cases, pending the revision of Papilionid genera by the Hon. Walter Rothschild, I shall only refer to the species in their specific character. It will, however, suffice by way of argument. The first to which reference may be made is the nauseous *Papilio philoxenus* (Moore's genus *Byasa*) which is mimicked by *Bootes* West. Now, without taking into account the other well-marked characters of the two genera, such as the general neuration of the wings, the shape of the discoidal cell of the hind wings, the large head of *Bootes* as compared to that of *Philoxenus*, the presence of an anal fold in the hind wings of the male *Philoxenus* and its absence in *Bootes*, take the evidence of one single character, a character too little appreciated and recognised, viz., the form of the basal cell; and, however similar the two species may be in general appearance (a similarity to which *Bootes* owes its existence), it is at once very easily seen from this evidence alone that they are representatives of two genera. *Byasa philoxenus* has a peculiarly shaped basal cell having the portion between the precostal and the costal nervures (the distocostal limb) of a markedly arched conformation and relatively longer than that of *Bootes*, and the portion between the base of the wing and the point where the subcostal originates (the mediocostal limb) relatively shorter than that of

Bootes, thus the basal cell in *Philoxenus* is wider slightly at its furthest edge from the base of the wing than that of *Bootes*, which is roughly diamond-shaped and has not the curvilinear form of *Philoxenus*. The curvilinear type of basal cell is found in a number of species which belong to a group of closely allied genera, and probably without exception to the nauseous type of Papilio. The other type of rudely diamond-shaped or angular form is found in a similar group of genera which invariably mimic either those of the curvilinear type or else other offensive butterflies. Thus *Agenor* ♀ mimics *Varuna; Memnon* ♀ mimics *Coon*. This illustration may give some idea of the value of the morphology of the basal cell for classificatory purposes in such butterflies as it is found: but I will go further.

The illustrations I have just given have been taken from the Indo-Malayan region, but for further evidence we will cross the Pacific Ocean and give a little attention to the Papilios of South America.

In the valley of the Amazon, and indeed generally in Venezuela, Ecuador, Colombia, and Central America there are to be found a number of Papilios belonging to the genera *Endopogon* and *Hectorides*, possessed of a curvilinear basal cell. They have also in common with the Indo-Malayan genera, a small head, an anal fold in the hind wing of the ♂, containing scent hairs, they are nauseous, and are in fact the representatives on the Eastern shores of the Pacific of the nauseous genera just mentioned from the Indo-Malayan shores. But the important point is (though only what one who had critically examined large numbers of these basal cells in other analogous groups would naturally expect) that they are mimicked by an inoffensive group of genera which have relatively larger heads, no anal fold of the ♂ hind wing,

and with a basal cell of the characteristic rudely diamond-shaped form, the limbs of which are straighter, indicating by these various characters their affinity to the Old World species. One species of these mimicking forms I will note, namely, *Eureleon* Hewitson, which is a good mimic, in its typical form and variety, of the heteromorphic species *Vertumnus* Cram.

Thus, to recapitulate, we have evidence of the basal cell structure of four groups of genera in two zoological regions, and the structure of this basal cell shows that two groups, one in each region, closely allied, respectively mimic two other offensive groups, one in each region, and also closely allied, thus:

	Old World.			
allied.	*Bootes*	mimics	*Philoxenus.*	allied.
	Eureleon	mimics	*Vertumnus.*	
	New World.			

Having given some idea of the value of the basal cell for classificatory purposes, a few illustrations of the various forms in certain families of butterflies will not be out of place.

In the family *Papilionidæ*, to a few genera of which some reference has just been made, the basal cell is constantly present, though its general form varies from a large, well-developed form with all its limbs well defined, a type of which is found in the African *P. zalmoxis* Hew., to a type with more elongated form, such as we get in *Vertumnus* Cram. It is found in every genus of the *Thaidinæ* which I have as yet examined; although in Schatz's figures it is not delineated as occurring in *Doritis* or *Ismene*.

In every species of another sub-family, the *Parnas-*

siinæ, I find it developed, though in a varying degree of development from a weak transitionary character, as in *P. apollo* C., to a well-formed type as in *Mnemosyne*, *Glacialis*, and *Stubbendorfi.*

In the *Pieridæ* the basal cell is found also to exist in a few genera. *Callidryas*, the type genus of the sub-family *Callidryinae*, shews it fairly well developed; the genus *Mesapia*, of the sub-family *Pierinæ*, has it, and in the diagnosis of the genus by Mr. Kirby in the *Entomologist* (Vol. XXVII., p. 101), he says: "A well-marked basal cell." In the *Leptocircinæ* a monogeneric (or perhaps truly bigeneric) subfamily of *Papilionidæ* it is also found. In the *Nymphalidæ* it is, as I have stated, present in *Danais*, *Amauris*, *Hestia*, *Caduga* and allied genera of the *Danainæ*; in the *Morphinæ* it is also found; but in the *Diadema* section of the *Nymphalinæ* (the section in which *Calinaga* is placed by Schatz and Kirby) there is no trace of it whatever, but in *Calinaga* it is found in a stage of development (or degeneration) equal to and almost identical in form with that stage as seen in *Parnassius*, that is the mediocostal is weak, the internocostal much weaker and apparently not wholly tubular.

To summarise:—the evidence of basal cell structure is that *Calinaga* is in its formation similar to *Parnassius* and dissimilar to the *Danainæ* and still less similar to *Hypolymnas.*

The existence of a basal cell in *Calinaga* appears to have been overlooked, and I am pleased to be able to shew the photomicrograph of this important structure. In Schatz's splendid work on neuration it is not shewn neither is it shewn to exist in the genera of *Thaidinæ* *Ismene*, and *Doritis*, nor also is it figured in *Parnassius* though, in various forms, it is found in every species which I have yet examined.

The only point in which *Calinaga* approaches the *Diadema* group of the *Nymphalinæ* is in the weakened upper discocellular nervure of the hind wings and the still weaker lower discocellular. In *Diadema*, for an example, the upper discocellular is similar in formation to *Calinaga*, but the lower one is entirely absent, leaving the wing cell open ; amongst the *Pierinæ*, however, we get certain genera, *Aporia*, *Metaporia*, &c., where, exactly as in *Calinaga*, the upper discocellular is stronger than the lower ; the antithesis to this is found in the *Danainæ* genera, *Caduga*, *Danais* and others, where the relative position is reversed, the upper discocellular being weak and the lower strong.

The Evidence of General Facies.

In discussing the evidence of wing-markings or general facies I shall not go into a lengthy description of the plan of coloration of the sub-family. There is not much variation in the disposition of the wing-markings in either of the two species, except one of degree. Generally speaking all the nervures are black, and in the inter-nervular area the centre portion is paler or hyaline more or less split up by the running outwards from the nervures of the dark scaling found on and contiguous to the nervures.* The Thibetan specimens of *Davidis* are generally dark suffused all over, whilst the Western China specimens are very much paler.

In the discoidal cell of the fore-wings of both species there is a dark transverse fascia stretching completely across the cell.

* An identical case of the breaking up of the internervular grey area into two can be beautifully seen by comparing specimens of *Metaporia, Largetani*, *Caphusa*, *Ariace*, and *Agathon.*

A characteristic of *Sudassana* is the beautiful rufous yellow suffused anal angle of the hind-wings above and in a very minor degree also below. The derivate of this colouring may be found in certain specimens of *Buddha.* I have one specimen from Sikkim which shews the first tinting of the anal angle. *Buddha* also shews a rufous colour on all exposed surfaces of the wings when folded over the back at rest. Another point of *Sudassana* is the long straight costa of the hind-wings, which is also found in typical *Buddha* and not in typical *Davidis.* Indeed it might be quoted to separate *Buddha* from *Davidis,* but however stable this character might be thought on comparing typical specimens it does not hold good when a number are examined. My own series, though not very large, show every intergrade between typical *Buddha* and the rounded and shorter costa of *Davidis.*

The females of *Calinaga* are in the known species semi-diaphanous and lighter in marking, a character not general in the *Nymphalidæ* but of the utmost constancy in the *Aporia* genus of *Pierinæ*, in the genus *Eurycus* of the *Parnassiinæ* and in the section of the genus *Parnassius* which includes *Mnemosyne*, *Glacialis*, and *Stubbendorfi.* But what of the dark transverse fascia of the discoidal cell of the fore-wings, which has no analogue in *Danais* or *Hypolymnas*, or in *Nymphalidæ* generally? It is very like that found in the whole of the *Parnassiinæ,* but in a form more like *Calinaga* in the *Glacialis* section.

I do not, however, attach too great importance to the general resemblance of wing-markings, as it is well known that the Lepidoptera are very susceptible to slight changes of environment, which cause greater changes of wing-marks.

But, however, the similarity to *Parnassius* is there, and the evidence of general facies re-iterates again and again the affinity and convergence of the three sub-families,

Calinaginæ, *Pierinæ* (section *Aporia*), and *Parnassiinæ* (section *Glacialis*, *Stubbendorfi*, and *Mnemosyne*).

A few words now as to the phylogeny.

We have seen from the evidence of distribution that it is probably an ancient butterfly, a probability I think transformed into a certainty when the structure of the ♀ feet is examined. The antennal structure shews an affinity to *Luehdorfia*, *Parnassius*, and *Papilio*, 3 genera representing 3 sub-families of the *Papilionidæ*. The egg is similar to *Danais* and not to *Hypolymnas*, with perhaps also a resemblance to *Pieris*.

The basal cell is strictly Parnassiine in its development. The discocellular nervules of the hind-wing is similar to *Hypolymnas* ♀, but not the male. The general facies is in part similar to *Parnassius*.

Thus the whole evidence of structure of this aberrant sub-family points to its being an archaic insect, with a great similarity to the *Papilionidæ*, in the sub-families *Papilioninæ*, *Parnassiinæ*, and *Pierinæ*, and to *Nymphalidæ*, in the sub-family *Danainæ*, but not to the sub-family which includes *Hypolymnas*. *Calinaga* thus appears to be an off-shoot, an early off-shoot, from the lepidopterous phylum which gave rise to the *Pieris*, *Papilio*, *Leptocircus*, and *Parnassius* and *Nymphalid* stock.

It almost marks the position at which the Pieris-Papilio-Parnassius phylum separated from the Nymphalid, but I think the male forelegs will place it on the Nymphalid branch as the first stage of the phylum.

EXPLANATION OF PLATES.

PLATE IV.

Fig. 1. *Calinaga buddha* ♂. Sikkim.
„ 2. „ *sudassana* ♂. Up. Siam.
„ 2a. „ „ under side. Up. Siam.
„ 3. „ *davidis* ♂. Thibet.
„ 4. „ „ ♀. W. China.
„ 5. „ „ apex of egg (micropyle).
„ 6. *C. davidis* portion of ova.
„ 7. „ neuration of right hind wing.
„ 8. *Danais limniace* „ „
„ 9. *Aporia cratægi* ♀. „ left hind wing.
„ 10. *Hypolymnas bolina* „ right hind wing.

PLATE V.

Fig. 1. *Calinaga buddha* ♂. fore leg.
„ 2. „ „ ♂. 5th tarsus of hind leg.
„ 3. „ *davidis* ♀. fore leg.
„ 4. *Neophasia menapia* 5th tarsus of fore leg.
„ 5. *Euryades duponchelli* 3-5 tarsi of fore leg. ♂.
„ 6. *Armandia thaidina* 3-5 tarsi of fore leg. ♂.
„ 7. *Aganisthos odius* tarsi of middle leg. ♀.
„ 8. *Hestia lynceus* tibia and tarsi. ♀.
„ 9. *Hypolymnas salamacis* fore leg. ♀.
„ 10. *Hebomoia glaucippe* claws, &c. ♀.

REFERENCE TO PARTS.

F = Femur.
Tar = Tarsus.
C = Claws.

S = Setæ.
Par = Paronychia.
Pul = Pulvillus.

PLATE VI.

BASAL PARTS OF HIND WINGS.

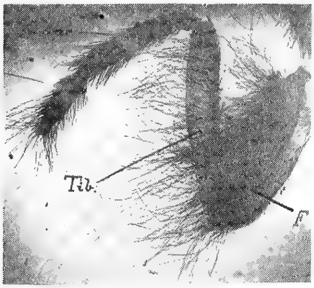
1. *Calinaga davidis.*
2. *Papilio montezuma.*
3. *Aporia cratægi.*
4. *Parnassius mnemosyne.*
5. „ *glacialis.*
6. *Danais limniace.*

REFERENCES TO PARTS.

B = Basal cell.	C = Costal nervure.
A = Antecostal nervule.	S = Subcostal nervure.
I = Internocostal „	P = Precostal nervule.
M = Mediocostal „	Med. = Median nervure.
D = Distocostal „	

CALINAGA.

1



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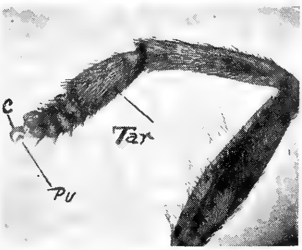

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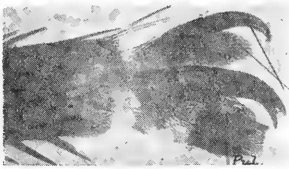

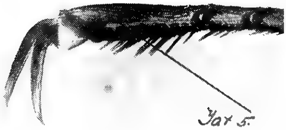

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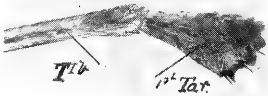

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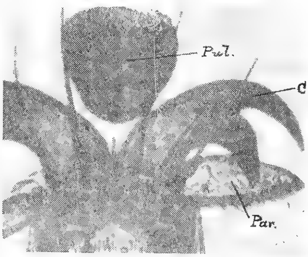
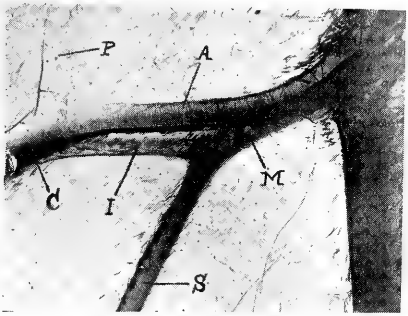


10

CALINAGA.

1



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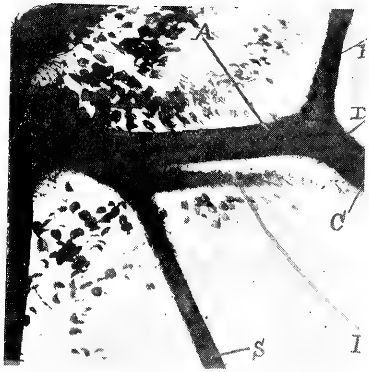

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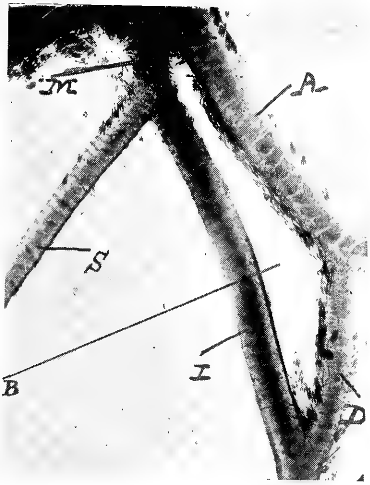

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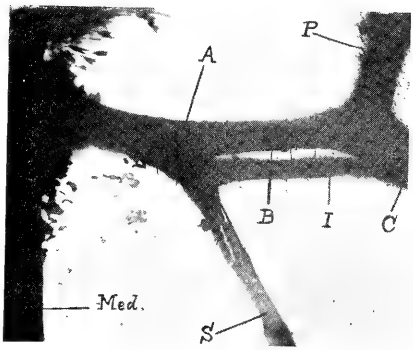

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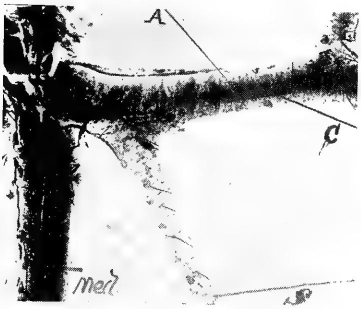

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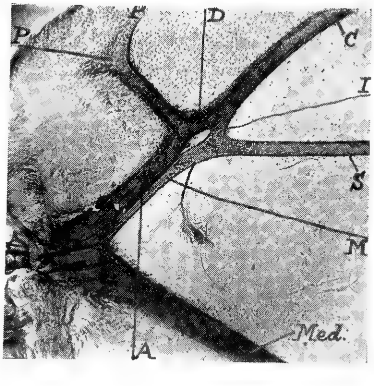

CALINAGA

Manchester Memoirs, Vol. xliii. (1899), *No.* **12.**

XII. On a Biological Aspect of Cancer.

By F. J. Faraday, F.L.S.

Read April 11th, received June 6th, 1899.

By the medical man and the general public disease is naturally regarded as an influence for the destruction of life. To the biologist or, to use even a wider term, to the philosopher who is fascinated by the deeper problems of nature whether relating to inorganic, organic, or organised matter, disease presents itself as a direction or evolution of vital force influenced by and influencing the environment. "Dead aerobies" Pasteur replied to Liebig, "become the prey of new aerobies of different species or of their own species." From this point of view it is at least convenient to provisionally assume the existence of Buffon's living molecules, whether we call them granulations or cells, the blastema of Robin, or the microzyma of Béchamp. We may conceive that, just as the elementary inorganic atoms or molecules have had impressed upon them by the Creator particular physical properties, combining proportions and resulting characters, so the living molecule is endowed with the special and equally permanent attribute of vitality. The chemist and the physicist find an inorganic molecule without its special properties unthinkable, and we may at least imagine a living molecule equally inseparable from its special properties. Just as the display or development of the potential powers of the inorganic molecule are largely dependent on the solution in which it is immersed, or the physical conditions to which it is exposed, so the living molecule may be said

to act in relation to the environment. But, as Lord Salisbury pointed out in his Oxford address to the British Association, there is an essential difference between the inorganic and the living molecules, in that the former do not breed. An elementary inorganic molecule may, by initiating a series of re-combinations, change the character of a solution many times its own weight; but it will not change the solution into a colony of molecules identical with itself. The living molecule decomposes or re-arranges the solution or *milieu* in which it is immersed; but it also reproduces an indefinite series of organised beings like itself by actually converting the surrounding material into such organisms.

There is another characteristic of the living molecules. They have the power of forming associations based on the operation of the economic principle of the division of labour. From this power results differentiation through many intermediate stages into roots, stem, leaves, and the various parts of the flower in the more highly organized plants; into blood vessels, nerves, ligaments, skin, and the various organs of the more highly organised animals. But, even still, regarded merely as a vital process, that is, leaving out of the question those ethical problems and results involved in the building up of a habitation for the soul of man, and for the exercise of his spiritual powers, the differentiations resolve themselves into merely a more highly complicated method of reproducing the organism. Apparently allied with this power of differentiation is the production of "sporting" varieties, the complete organism being thus itself liable to variation in its ultimate form, and apparently retaining the power, under certain conditions, of reproducing its variations so that the progeny of the most highly organised resultant form tends to reproduce in its own life-history all the differentiations of

the parent or parents. The power of differentiation is conveniently expressed by the word evolution ; the power of the reproduction of the biological experience of the parent cells apparently inherent in living matter, by the word heredity.

Coming back now to our simple living molecules we have to recognise in them two methods of breeding, reproduction by mere scissiparity, the living cell dividing itself into two or more, or reproduction by differentiation as members of a community resulting in spores, or seeds, or eggs, which seem to contain in themselves the organic memory, if I may so express it, of all the phenomena of their descent. The differentiation and division of labour characteristic of the latter mode of reproduction may extend even to a division into separate communities, the co-operation of which is necessary for the reproduction of either community *as a whole;* in other words into the evolution of the sexes as in monœcious plants and the higher animals. It will be sufficient for the present to sum up these two methods as reproduction by scissiparity and by eggs, merely remarking that reproduction by true seeds or eggs is a more advanced stage of differentiation, or communal division of labour, as compared with reproduction by spores, just as reproduction by spores is an advance on reproduction by mere scissiparity, and may be spoken of as a first attempt at communal work. But here we must recognize that reproduction by scissiparity implies merely the reproduction of the individual cell, while reproduction by spores implies the reproduction of the primitive tribe, and reproduction by seeds or eggs the reproduction of the highly organised society. Both the simpler methods have been observed in the lowest forms of life. Thus, anthrax may grow as mere mycelium by cell division or, if cultivated under appropriate conditions, it will produce spores which

will be liberated as germs of independent communities or growths through the dissolution of the mycelium, which, like summer annuals, having surrendered its vital force to its offspring, crumbles away.

Now, may we not carry the thought a little further and assume that both possibilities are inherent in the original cell or living molecule? The potentiality of variation, division of labour, and co-operation must be assumed as existent in every cell, otherwise how could cells ever have become highly organised communities? Moreover, experience has shown us, what in any case we should have been obliged to infer as the only possible explanation, that the development of one or the other tendency must be determined by the environment, or the conditions under which the particular life has to be carried on. Thus the character of the season will determine whether a tree will make wood or flowers, whether the wheat plant will make much straw or a full ear. Place a leguminous seed or tuber in the darkened portion of a cellar, it will send forth long shoots of mycelium until it obtains the direct contact of the solar rays, when the differentiations which result in inflorescence will begin. And whether anthrax will produce spores, or not, has been said by various observers to depend on the presence or absence of free oxygen.

I have spoken of reproduction by eggs as a general expression for reproduction by spores, seeds, or eggs as distinct from reproduction by mere scissiparity. But, technically, we apply the term spore to what may be spoken of as the seeds or eggs of the lower forms of life; in other words of the less highly differentiated communities of cells. These may be regarded as representing an intermediate stage between the simple cell or living molecule and the highly complex organism, say man, in which what I may call economic differentiation has attained its

maximum development. May we not further suppose that each stage is represented in the higher organism and retains all its original and acquired potentialities? That the cells of the higher organisms retain their power of mere scissiparity we know, for it is by such reproduction that the plant or the animal grows; may not particular tissues corresponding to the higher cryptogamic stage of plants, above the thallophyta—say the ferns—have a tendency under given conditions to revert to independent spore production with the resultant decay of the parent mycelium? This would be as though the leaves of a phanerogam forgot their duty to the community represented by the whole plant and began to produce spores; or as if the workers in a hive began to lay eggs instead of leaving that duty to the queen bee. Some of the phenomena of scarlet fever might perhaps be accounted for as due to some condition which awoke in the skin-tissue, the potentiality of independent spore formation. The initial stages of cancer, and of the various forms of epithelial proliferations may under this view be conceivably due to some change of environment, which setting free and even stimulating the power of independent multiplication by mere scissiparity in a particular region or in one or more cells, at the same time arrests the tendency to differentiation in the service of the community or of the general organism. In that case the cancer, in its initial stages, would be a case of arrested development, or of reproduction not proceeding beyond the original mere cell-formation stage, the result being a local growth of an independent, or non-cooperative, character.

Cancer has been defined as epithelial proliferation with an invading tendency, and this invading tendency seems to be truly parasitical, as the invading cells appear to destroy, or absorb, or replace the normal tissues around.

Assuming, then, the first stage to be merely the exertion and stimulation of the inherent property of cell multiplication, with arrested differentiation into (let us say) blood channels and nerves, the complete renewal of the circulating and nerve systems of the subject being thus locally interrupted, with consequent disturbance to the general health, and a certain isolation of the affected part (like a secret society of malcontents in a State), how do the new cells acquire a parasitical character? An explanation may possibly be found in what we know of microbe life. Zymotic diseases are generally attributed to the actual invasion of the body of the sufferer by a previously existing pathogenic microbe, and cancer itself has been declared to be probably infectious and to be due to a pathogenic organism. The views which I am endeavouring to develope are not inconsistent with these hypotheses. The immediate question is merely that of the evolution of the *micrococcus* and of its malignant character.

I have long held the opinion—as being most consistent with the phenomena of the appearance and disappearance of epidemics and with Pasteur's attenuation experiments—that pathogenic microbia are, to begin with, harmless or even benignant saprophytes or organised ferments, which, through changes in the environment, have been compelled to take up a parasitical or malignant character in obedience to the law of the struggle for existence. In a paper read at the meeting of the British Association in 1882,* I based on Pasteur's discovery of the attenuating influence of free oxygen on pathogenic microbia, and on the vastly increased destructiveness, or fermenting power, of the harmless yeast plant when cultivated in deep vats—which are speedily

* Report of the Fifty Second Meeting of the British Association, held at Southampton in August, 1882, p. 578.

exhausted of free oxygen and are protected from fresh supplies by the layer of carbonic acid formed above—the hypothesis that Koch's tubercle bacillus is an originally harmless saprophyte or digestive ferment which has been converted into a destructive parasite by imprisonment in lungs inefficiently aerated, either in consequence of hereditary weak breathing habits or other obvious causes. The view is a more hopeful one than that which indefinitely multiplies species by giving to every pathogenic microbe a permanently specific character; for in the former case we may hope to escape disease germs by sanitary conditions which prevent their evolution, while in the latter our escape is a mere matter of good luck.

It is well-known that the cancerous growth after removal by surgical operation, even to the extent of amputation, will often *re-appear* in other parts of the body. Now, it is authoritatively stated that the cells of such second growths have always the characteristic form, not of the epithelial cells of the locality of the second outbreak, but of the region where the disease first appeared. Thus, let us take two remote portions of the body, A and B. If the disease first appears at A, then a re-appearance at B will have the characteristic cell formation of the epithelium at A; if, on the other hand, it originates at B, and re-appears at A, the growth at A will have the characteristic cell formation, not of the epithelial cells of A, but of those of B. The only explanation yet put forward is that a morbid cell from the original growth has escaped and been conveyed by the blood vessels or the lymphatics, as a travelling cell, to find a lodgment where it can parasitically develope a new colony. The characteristic form of the cells of the morbid growths clearly indicates their descent from the originally healthy cells of the epithelium where

the growth first appeared. Here then we have healthy cells becoming malignant, in the first place through some condition of the environment. Then one of the converted cells escapes, travels, and sets up a parasitic colony elsewhere. Such a travelling cell is, to all intents and purposes, a pathogenic micrococcus evolved from originally healthy cells. Let us recapitulate. We begin with a healthy epithelial tissue, the cells of which are capable of differentiation to fulfil the various co-operative functions required. Owing to some change in the environment, or say the food supply for the renewal of the tissues, they lose their differentiation power and revert to, or remain at, what I may describe as the simplest cryptogamic or thallophyte stage of their life-history. Under the changed condition their vital activity developes itself in purely algaceous or fungoid growth, and for the same reason, and under the influence of increasingly abnormal conditions, they eventually develope a parasitic power. A cell then escapes and, as a pathogenic micrococcus, sets up, under the same favouring conditions, similarly parasitic colonies elsewhere. Is not such an assumed development of morbid virulence analagous to the variation from the "vaccine" to the deadly *contagium vivum*?

But we have now to ask ourselves why this arrest of development at what may be called the mere cryptogamic stage, and why this development of vigorous parasitism? In endeavouring to answer these questions we must first recognize the fact as demonstrated, that changes in the chemical and physical environment have an extraordinary influence on the lower forms of life. It has been abundantly demonstrated that the cultivation of microbia in the absence of free oxygen and sunlight developes parasitic vigour in an extraordinary way, and that free oxygen and sunlight are inimical to parasitic vigour.

I would venture to express the view in a broad generalisation :—Free oxygen and sunlight are favourable to phanerogamic development, their absence to cryptogamic life. If we go back in geological history we find that when the world was probably largely enveloped in carbonic acid gas and the vapours of steaming seas, the great filicinæ, equisitaceæ and lycopodinæ, and the enormous lizards and other sluggish forms of life prevailed. Their huge bodies testified to conditions favourable to the growth of mere (relatively) undifferentiated mycelium, rather than to the evolution of the complex nerve tissues and highly elaborated system of well-ordered canal irrigation by means of sap and blood vessels characteristic of the higher plants and animals. It does not seem entirely fanciful to associate the prevalence of the degenerative processes of cancer along river valleys with this generalisation. There appears also to be a striking relation between cancer and tuberculosis. Dr. Thorburn, for instance, has found statistically that there is frequently a family history of tuberculosis in cases of cancer. Tuberculosis we know to be associated with deficient light and ventilation, and the mists or vapours of river valleys suggest less efficient oxygenization of the blood than takes place in dryer localities. However that may be, such deficient oxygenization does not seem an insufficient cause to account for cryptogamic arrest, or reversion, on the part of the cells or micro-cocci of which the human being is built. In the case of cancer, a bruise, or any interference with the efficient oxygenization of the part by the blood stream may initiate the local growth. But if we assume imperfectly oxygenized blood throughout the body, the escaping cell starting from the original centre in which its malignant vigour has been nurtured, lodges amidst tissues which are themselves being imperfectly renewed

and which, therefore, fall an easy prey to its developed parasitic virulence. Let us imagine the life of such a colony. We begin with an imperfectly irrigated centre, or a centre irrigated by poisoned streams, the cells in which are consequently arrested at the cryptogamic stage, while the surrounding tissues are themselves weakened by an imperfectly renewed blood supply. As the fungus growth proceeds and increases, the channels of irrigation and the nerve fibres which should convey the mysterious neuro-stimulus are themselves degenerated and broken up, while the centre of the fungoid growth itself is imperfectly nourished ; the peripheral cells, acquiring increased cryptogamic vigour march on as an invading army, feeding on the surrounding fields of tissue. As the mass increases the famished area becomes larger and the interior breaks down and ulcerates, becoming the prey of still more residual vital forces or pathological ferments developed or liberated in its own substance.

The practical conclusion is that there has been perhaps too great a disposition to regard cancer as a foreign invasion, and as pre-eminently a case for surgical treatment. If there be anything in the reasoning which I have ventured to present it would appear to be primarily a matter for the care of the physician. As in tuberculosis, so in cancer, measures for securing the more efficient oxygenization and thorough circulation of the blood might possibly be tried with advantage, and it also seems to be worth inquiry whether the introduction of oxygen locally and in a concentrated form might not be practicable and advantageous.

The influence of free oxygen as a biological factor is more extraordinary than is generally recognised. Let me quote Pasteur's statement* respecting ordinary moulds. " If," he says, " the plant has at its disposal abundant air,

* Études sur la Bière. Par M. L. Pasteur. Paris, 1876. Page 134.

if it grows on the surface of a humid body or in a liquid where the contained air can be renewed without being displaced by carbonic acid gas, one observes an ordinary mouldiness with a mycelium consisting of more or less slender tubes, branched and interlacing, and producing on the surface of the liquid aerial organs of fructification. Everyone is familiar with such growths of common moulds. But introduce the mould into a sugar solution with insufficient air, the growth changes completely, as we have already seen submerged *penicillium*, *aspergillus* and *mycoderma vini* change, only in a more pronounced manner. The spores which are sown for the crop become much enlarged, and the mycelium tubes which proceed from them are much thicker and stronger than in the normal plant. These tubes produce, at relatively greater distances from each other, branch tubes, which detach themselves and set up a separate vegetation on their own account, producing at their extremities, or having their own continuity broken by, chains of large cells which can live by budding and reproduce cells similar to themselves, which also grow into tubes." Does not this description of the change in the growth of a mould—from a delicate moss-like structure to a mere thallophyte—in the absence of free oxygen, with the enlargement and more leathery consistence of the cells, suggest the alleged enlargement and thickening of the characteristic epithelial cells in the cancerous growth? While the higher organisms or organizations of life cannot exist without oxygen, there are lower forms of life which do actually thrive in its absence; even the larval forms of higher organisms are able to exist under gaseous conditions which would be fatal to the fully developed creatures. It was not without reason that oxygen was called the vital gas; in its absence the living cells seem to forget their life

history and to retain only their fundamental vitality, limited as to form, but intensified in individual vigour.

What can be more remarkable than the fact that the presence or absence of a particular gas in a free form determines, not the life of a plant, but whether it shall reproduce by mere cell division or by the wonderfully complex process of yielding spores or seeds, which contain in an altered form the possibility of reproducing the parent ; or that the presence or absence of light shall determine whether a leguminous plant shall produce yards of mere mycelium, or the extraordinary variation, elaboration, and co-operation of inflorescence and fertilisation ?

The successful application of oxygen in cases of pneumonia is also suggestive. In these cases oxygen is applied for the purpose of maintaining the blood in good condition and keeping up the action of the heart, in other words the method is to do artificially what the lungs, through the progress of the disease, have become incapable of spontaneously doing. But it ought not to be overlooked that this artificial application appears not only to do the work of the lungs during their state of incapacity but to stop the progress of the disease itself, thus restoring the lungs to a normal state.

NOTE, AUGUST 7TH, 1899.—Since the foregoing paper was set up in type my attention has been directed to the fact that Cohnheim's hypothesis (with which I was not previously acquainted), that morbid growths of the nature of cancer may arise from minute portions of embryonic tissue which have persisted in an undeveloped state amongst the mature tissues, in some respects seems to be related to the hypothesis I have put forward. With reference to this and other previous suggestions and investigations, I wish to say that there are differences in detail, and more especially in the point of view, which have appeared

to me to justify the publication of my own speculation. On this point I may perhaps usefully quote the remarks of an esteemed correspondent, who is also a distinguished specialist. "Your view of the etiology of cancer," he writes, "is in some respects parallel to that of Cohnheim, though it differs in this, that whereas he regarded the cancer cells as cells which had *retained* the undifferentiated embryonic characters, you (as I read it) regard them as having *re-acquired* those characters by the action of detrimental agencies acting upon them from within or without. This, as you say, does not exclude the possible action of parasites as the cause of the degeneration; your bias is, however, obviously towards the side of a physical causation, more especially deficiency of oxygenization."

With reference to my remarks on disturbed or interrupted irrigation, my attention has also been called to the evidence of an abundant supply of blood to the affected parts, which is indicated, for instance, by the number of arteries requiring ligature after an operation. On this point I wish to say that the pathological descriptions of this phenomenon which I have read suggest congestion rather than healthy circulation; in external nature we have sluggish water courses which tend to the formation of a miasmatic area. An excessive blood-supply, moreover, seems mechanically and chemically inconsistent with complete oxygenization.

Finally my appreciative and friendly critic points out that cancer appears in (apparently) very robust persons; that there is a form of cancer which occurs almost exclusively on the area of the body most richly supplied with blood, the face; and that it has been noticed that almost the only victims to this form in Hamburg are sailors, who of all people may be supposed to be most abundantly supplied with free oxygen. I wish it to be understood that I refer to oxygen in the paper rather as an illustrative speculation than as a suggestion on which depends absolutely the general argument of the paper, that of a biological change due to alteration of environment—say nutrition or nerve stimulus. But in regard to a disease which is admittedly involved in mystery, it is useful to have a definite working hypothesis. If the oxygenization idea is adopted as such an hypothesis, then the case of the Hamburg sailors will present itself as an exception

to the rule; and, with a due exercise of lateral vision, other special conditions of the lives of German sailors might be found competent to counteract the apparently healthy conditions, and to produce such a de-oxygenized state of the blood as might be expected in cases where the supply of atmospheric oxygen was actually deficient. Even on the simplest hygienic principles, the development of morbid growths in the presence of abundant fresh air and sunlight must be regarded as exceptional in either the vegetable or animal kingdom. Should the lateral observations result in the discovery of competent causes, *with or without efficient oxygenization*, the working hypothesis would have lived a useful life and would have an honourable death.—F. J. F.

PROCEEDINGS

OF

THE MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 4th, 1898.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

It was announced that, during the recess, the Society had lost by death four ordinary members:—Mr. H. M. Ormerod, F.G.S., Dr. R. M. Pankhurst, Dr. James Rhodes, and Mr. John Wright; and three honorary members:—Professor Ferdinand Cohn, Lord Playfair, K.C.B., F.R.S., and Mr. Osbert Salvin, F.R.S.

Mr. TRISTRAM remarked on a phenomenon which he observed in a bright sky and near the zenith, on Wednesday, September 28th. The appearance might be described as a double fragment of rainbow, the two parts resembling somewhat the script letter *x*, one part being a short arc of a circle, having the sun as centre, the reversed part touching it. The colours were distinct but not bright, and the two parts were about equal both in size and brightness. The phenomenon was observed during several hours both before and after noon, and the effect seemed to be produced upon some exceedingly light and elevated clouds. It gradually faded as the sun drew near the horizon.

Mr. H. W. FRESTON exhibited a male specimen of *Asagena phalerata*, an extremely rare species of spider, which by itself represents the genus *Asagena*, whose nearest congener is the genus *Steatoda*. The present individual is the only male that has been found, at any rate in recent years. Previously the habitat of this species was unknown, but it would now seem to be a simple Theridion snare in grass amongst rocks. This specimen was found in August, on Redbank, above Grasmere. The most striking features of the genus are a denticulated edge to the cephalothorax and a denticulated socket in the front of the abdomen, forming a stridulating apparatus, which would produce a squeaking noise when rubbed against the rough hinder edge of the thorax.

Mr. JOHN BUTTERWORTH read a paper, entitled, "**Further Research on the structure of Psaronius, a Tree Fern of the Coal Measures, and on the Leaf Sheath surrounding the Nodes of some of the Calamites of the Lancashire Coal Measures.**"

The PRESIDENT, Professor WEISS, and Mr. MARK STIRRUP criticised some statements in this paper.

This paper has been revised by the author and is printed in full, as revised, in the *Memoirs*.

General Meeting, October 18th, 1898.

James Cosmo Melvill, M.A., F.L S., President, in the Chair.

Mr. E. W. Donovan, M.I.Mech.E., Prestwich, was elected an ordinary member.

Ordinary Meeting, October 18th, 1898.

James Cosmo Melvill, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. J. J. Ashworth exhibited a plant (*Zea mais*) grown at Wilmslow, together with a ripened and an immature cob.

A paper by Mr. Peter Cameron was then read, entitled: **"Hymenoptera Orientalia, or Contributions to a knowledge of the Hymenoptera of the Oriental Region. Part VIII. The Hymenoptera of the Khasia Mountains."**

This paper is printed in full in the *Memoirs*.

Ordinary Meeting, November 1st, 1898.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

A discussion on the aurora borealis, with special reference to the display on September 9th last, was opened by Professor OSBORNE REYNOLDS, and part was taken in it by several of the members present.

A discussion on the subject of electric tramway traction was then initiated by Dr. F. H. Bowman with special reference to the methods now adopted in Berlin.

Ordinary Meeting, November 15th, 1898.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. STROMEYER called attention to some difficulties which he had met with in applying Fourier's methods to the consideration of the conduction of heat in boiler plates, and in considering the motion of spiral springs suddenly released.

Dr. G. H. BROADBENT described the development and life history of *Vorticella putrina* by means of 34 diagrams made from his own observations. The development from the cyst was fully given in each stage, the remarkable feature being that after the extrusion of the organism through a very small aperture the cyst wall remained quite circular and intact. The manner in which the Vorticella leaves the stalk by means of the development of basal cilia was shown, and it was stated that the free-swimming form steers with these cilia foremost, whereas in the "detached" form—a special term used by the author—the oral cilia are foremost. He mentioned that he had seen the stalk contract on its own account after the organism had already left it for several seconds.

General Meeting, November 29th, 1898.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

Mr. Walter Behrens, Manchester; Mr. Alfred Hopkinson, Q.C., B.C.L., Principal of Owens College; Mr. J. W. M'Connel, M.A., Prestwich; and Mr. F. W. Gamble, M.Sc., Demonstrator in Zoology, Owens College, were elected ordinary members.

Ordinary Meeting, November 29th, 1898.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Professor LAMB made some remarks upon Professor Klein's recent work on the motion of the top, and illustrated some points by means of a gyroscope.

Ordinary Meeting, December 13th, 1898.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

DR. G. H. BROADBENT described microscopical observations he had recently made on the development of a rotifer existing in an infusion, made in January last, of the mud deposited on his bicycle. On Friday, the 2nd inst., the organism was found, and on the 4th the ovum was extruded, and was under observation until the 6th, when it was lost. On the 7th instant another was found, and the stages of development observed day and night, with only seven hours intermission, until the 11th, when it emerged from the ovum fully formed. His communication was illustrated by a number of diagrams.

A paper by Mr. PETER CAMERON was read, entitled **"Description of a New Genus and Species of Hymenoptera from Chili."**

This paper will be printed in full in the *Memoirs*.

Dr. J. LAWSON RUSSELL, of Todmorden, then read a paper, entitled **"Vestiges of Primitive Man found near Todmorden."**

Ordinary Meeting, January 10th, 1899.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. C. L. BARNES called attention to a paper by Dr. Wollaston in the *Philosophical Transactions* for 1824, "On the apparent direction of eyes in a portrait." The difference between portraits in this respect is well known, the eyes appearing either to follow a spectator all round the room, or to be always looking in some other direction. Dr. Wollaston shews that the effect is partly due to the apparent direction of the eyes considered by themselves, and partly to the perspective of the nose and other portions of the face. In the volume referred to are several plates in which the same eyes can be viewed in connection with different faces, and the change in the apparent direction is most marked. Other descriptions of a similar kind are also illustrated and explained.

Dr. BOWMAN called attention to a small light streak on the upper limb of the moon when totally eclipsed on the 27th of December; the position appeared to be about what would be represented by eleven o'clock on a dial, and had a small indent in the centre. The brightness was much greater than the remainder of the copper-coloured surface, and the phenomenon was never observed to entirely disappear during the whole time of totality. Mr. Tristram noticed the same phenomenon during the earlier stage of the totality.

Mr. GWYTHER mentioned that he had seen a lunar halo, lasting for a short time only, just after 10-30 on the night of the 28th of December.

Ordinary Meeting, January 24th, 1899.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

The PRESIDENT announced that the Council had awarded the Wilde Medal of the Society for 1899 to Sir Edward Frankland, K.C.B., F.R.S., and the Wilde Premium to Charles H. Lees, D.Sc.; that Professor William Ramsay, F.R.S., had been appointed to deliver the Wilde Lecture, and that the date of presentation of the Wilde Medal and of the delivery of the Wilde Lecture had been fixed for Tuesday, the 28th of February.

Dr. F. H. BOWMAN mentioned that he had recently seen a specimen of wheat, grown in South Africa, consisting of about 420 stalks, apparently produced from one seed, each stalk having an ear containing on the average 40 grains of wheat. The President and Mr. C. Bailey agreed that the plant was most probably *Triticum compositum.* Mr. Tristram stated that plants consisting of 190 stalks had been grown in Lancashire.

Mr. C. E. STROMEYER exhibited a number of photographs illustrating the extent and character of the damage effected by the recent boiler explosion at Monton.

The PRESIDENT exhibited a specimen of *Eichhornia speciosa* Kunth., and remarked that it cannot be too widely circulated that very great danger attends the cultivation of this showy plant or its introduction into tropical or subtropical countries, where it might be thought to add to the beauties of lakes or ponds in Botanical Gardens and elsewhere.

Originally a native of South America, it was about nine years since introduced into Florida, in an ornamental sheet of water not far from St. John's River. It was soon found to have filled up this space, and a stray offshoot having accidentally found its way to the river, the growth was so rapid and so effectual as to convert portions of it into the semblance of green

meadow-land, and, it is affirmed, to stop the progress of boats and even steamers. In Louisiana similar disasters have occurred: the climate seemed exactly to suit the plant, and Government aid had at last to be invoked, and steam-dredgers used to extirpate it. This was very difficult, for if even a small piece of the matted roots was left, fresh offshoots would rapidly grow, and flower the first season. Indeed, in the Bayou St. John in the same state (Louisiana), no means have been found effectual to stop its incursions, where once it has obtained a footing. The timber industry was threatened, as rafts could not be sent down the river. Grand Lake, not far off the Bayou, has likewise been invaded. This vast expanse of water, forty-five miles long by an average of six broad, is in parts already like a wide meadow, spangled with most beautiful purple hyacinth-like flowers. Cold weather alone seems to stop its increase, and it then sinks to the bottom of the river, but, with the approach of warm weather, rises again and propagates very rapidly.

Eichhornia Kunth, Enum. Pl., iv. 129 (1843) is a small genus of the Nat. Ord. *Pontederiaceæ*, containing about seven species, all natives of tropical America, except one W. African. The four genera composing this small order, viz., *Pontederia* L., *Eichhornia* Kunth, *Heteranthera* R. and P. (inclusive of *Schollera* Schreb.) and *Monochoria* Presl, are all much alike, possessing spikes of hermaphrodite flowers in most instances, often very regular. Perianth usually six-lobed, stamens varying from three to six, unequally fixed to the base of the segments, filaments free, filiform. Anthers oblong. Style filiform or columnar. Fruit loculicidally dehiscent, dividing its three valves with a membranaceous pericarp. Ovary free as a rule, 3-celled, ovules anatropal. The flowers are spathaceous, leaves sheathing cordate or sagittate, with inflated petioles. Species about 33, *Pontederia* being all American, *Eichhornia* (as already mentioned) American and W. African, *Heteranthera* the same, and *Monochoria* entirely of the Old World, one species, *M. vaginalis*, being of very wide distribution.

If we consider the strict law of priority, the name *Eichhornia*

Kunth, 1843, is antedated by *Piaropus* Rafin.,* 1836, and the specific name *speciosa* Kunth by *crassipes* Rafin. (*l. c.*)

Mr. CHARLES BAILEY explained the structure of the peculiar permanent sheath which encloses the extremity of each root and rootlet of the *Pontederia (Eichhornia) crassipes*. The specimens exhibited to the members, under the microscope, showed that these sheaths were like the long finger of a glove in shape, and varied in size according to the age of the organ. The organic connection between the root and its sheath is found at its extremity at the bottom of the sheath. These are of fair consistency, and are doubtless designed for the protection of the plant which, by means of its inflated leaf-stalk, passes its life floating upon the surface of the water; the growing and tender extremities of the root are in this way guarded against the attacks of the smaller aquatic animals. The species of the cryptogamic genus *Azolla*, which also pass their existence in a floating condition, have a very similar root-sheath, but in their case the organ is only temporary, being discarded before the root reaches maturity.

The PRESIDENT read a note "On the occurrence of *Chenopodium capitatum* Ascherson, near Llandudno."

This plant, more commonly known by the Linnean name *Blitum virgatum*, was found by myself at Craig-y-don, Llandudno, on waste ground, locally abundant, not very far from the Little Orme's Head, in September, 1898. It has been from time to time recorded as a casual in the British Islands, and Mr. F. J. Hanbury informs me that he has a specimen in his herbarium, collected by the late Dr. Boswell (Syme) at Fisherrow, near Edinburgh.

It is figured in Curtis' *Bot. Mag.*, Pl. 276, and used in old times to be cultivated for ornament, the scarlet, round, axillary clusters of fruit being conspicuous and suggesting the trivial name "Strawberry Blite." The flowers are very small, one-stamined, two-styled.

Opinions differ considerably as to the exact generic position

* Fl. Tellur. II. 81 (1836).

of this plant. Hooker (*Fl. Brit. India*, V., p. 5), under the name *Chenopodium Blitum*, places it in his third (Indian) section of that genus, owing to its baccate fruit. Boissier (*Fl. Orientalis*, IV., p. 905) assigns it to the genus *Blitum*, associated with *Chenopodium Bonus-Henricus* L. and *C. rubrum* L.

Nyman (*Conspect. Fl. Eur.*, p. 623) gives two species, *B. capitatum* L. and *virgatum* L., the distribution of both being much the same as far as Northern and Western Europe are concerned, ranging from Norway and Sweden to Germany, Helvetia, France, etc., but the latter (*B. virgatum*) extends also to Transylvania, Servia, Roumania, and Russia. Its geographical distribution in the East seems also extensive (Boissier *l. c.*), including both Asia Minor, Armenia, Transcaucasia, Persia, M. Libanus, and Afghanistan. It is also reported from N. Africa, *e.g.*, Algeria (Munby). *B. capitatum* merely seems to be a large-leaved and fruited variety, with occasionally leafless spikes as well as axillary inflorescence, and, as the plant is connected with the typical *Chenopodia* through intermediates such as the above-mentioned *C. rubrum* L., it is no doubt the wisest course to sink the genus *Blitum* in the larger assemblage of *Chenopodium*. I may add that I have in my herbarium a North American sheet of this plant (of the form *B. capitatum* L.) from Gilpin County, Colorado, collected by R. W. French in 1874, and I have also specimens from a few other localities in the United States.

The PRESIDENT also read a note "On the order *Ilicineæ*."

The Order Ilicineæ comprises trees or shrubs, for the most part evergreen, smooth, eglandular, the leaves being in all cases alternate, without stipules, shiny, coriaceous, often margined, crenulate or spiniferous. Certain of the sub-genus *Prinos* of *Ilex* are serrate, deciduous, tender. The inflorescence is either axillary or terminal or both, occasionally solitary. Flowers regular, diœcious or unisexual, usually white. Calyx mostly four to six-partite. Petals, in *Ilex Aquifolium* four (occasionally, in other species, five), hypogynous, imbricate. Stamens usually the same in number as the petals. Filaments subulate. The

ovary is globose, free, mostly four to five-locular. The fruit is carnose, with as many stones as cells in the ovary.

Three genera are admitted by Bentham and Hooker in the "Genera Plantarum,"* and these are maintained by Durand,† with the addition of *Sphenostemon* Baill. (1875) from New Caledonia.

The three original genera are as follow :

1. *Ilex* L. (*Prinos* L.) sp. 175. Orbis totus.
2. *Byronia* Endl. sp. 3. Australia tropica ; Ins. Sandvichenses ; Tahiti.
3. *Nemopanthes* Rafin. sp. 1. America borealis.

It will thus be seen that of the 180 species included in the Order, no less than $\frac{35}{36}$ths belong to the widely-distributed *Ilex*, of which only one species, our common Holly, occurs in Europe, or indeed in the region traversed by the "Flora Orientalis" of Boissier.

The geographical distribution of the *Ilex Aquifolium* L. is as follows :

Europa omnis, præter Scandinaviam (tantum in Daniâ et Norvegiâ meridionali ‡) Fenniam, Rossiam, Transylvaniam, et Græciam (solum in monte Delphi).

In Macedoniâ, Thraciâ, Euboeâ, Byzantio, Bithyniâ, Ponto, Mingreliâ, Iberiâ Caucasicâ, Persiâ boreali. (Boissier.)

In Africâ boreali.

It does not, therefore, extend to India, nor is it found in North America, where its place is taken by the superficially similar *Ilex opaca* Ait. (*quercifolia* Meerb.), with leaves of much softer and less glossy substance.

The Holly varies in width and breadth of leaf, in quality and quantity of spines and in coloration, the variegated forms being extensively cultivated. Of these the state aptly named "*ferox*" is one of the most singular.

The var. *balearica* Desf. is a broad-leaved, almost espinose variety, and it may be that the *I. canariensis* Poir., with giant

* Vol. I., p. 356. † *Index Generum Phanerogamorum*, p. 65.
‡ Nyman, *Conspectus Fl. Eur.*, p. 144.

foliage, may only be another subtropical form of this protean species.

Amongst the many exotic forms the *I. vomitoria* Soland. (*Cassine* L.), which I have gathered commonly on the sea-coast of S. Carolina, a remarkably neat, dwarf shrub with shining small crenate leaves, and crowded red berries, is mentioned by Porcher * to be used in place of opium by the Indians, who make a cold infusion of the leaves which is called the "black drink." It was also used by the Creek Indians as a powerful diuretic. It is used as an emetic in the same way as the *I. paraguensis* A. St. Hil., the Maté, or Paraguay Tea. It is locally called "Yaupon." The Inkberry (*I. glabra* Gray = *Prinos glaber* L.), another common species in the Southern States, is also occasionally employed as a febrifuge and for making decoctions of opiate tea.

I. (Prinos) verticillata Gray is a serrate-leaved form, growing in swamps with the last-named, than which it seems an almost more valuable plant, the bark and berries both being used, by the Indians especially, for gastric diseases and as a corroborant in dropsy.

Indeed, it is probable that almost all the species of the true Hollies have similar qualities; the bitter principle is termed "ilicin," and is considered by some to be almost as efficacious as quinine (Cinchona). Lastly, birdlime can be procured from the inner bark of the Holly, as well as from the berries of the Mistletoe.

Of the two other genera consigned to this Order, *Byronia* Endl. is much like *Ilex*, and, indeed, Sir J. D. Hooker (*Fl. Brit. Ind.*, Vol. I. p. 598) states that the genus must be now suppressed, as various important modifications of the ordinal character have been made.

Nemopanthes Rafin. includes a North American species, with deciduous, smooth, mostly entire leaves, flowers on long axillary peduncles, nearly or quite solitary. This I have gathered near Trenton Falls, N.Y.

* *Resources of the Southern Fields and Forests*, by F. Peyre Porcher, M.D., Charleston, 1871, p. 431.

Specimens of about sixty varieties of *I. Aquifolium* L. and many other subtemperate and tropical species of the genus, were also exhibited, as well as specimens of the two other genera, *Byronia* and *Nemopanthes.*

General Meeting, February 7th, 1899.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair

Mr. D. L. Chapman, B.A., Demonstrator in Chemistry, Owens College; Mr. W. T. Lawrence, B.A., Ph.D., Demonstrator in Chemistry, Owens College; and Professor A. S. Wilkins, M.A., LL.D., Professor of Latin, Owens College, were elected ordinary members of the Society.

Ordinary Meeting, February 7th, 1899.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

The PRESIDENT appointed Mr. Thomas Thorp and Mr. H. W. Freston to be auditors of the Society's accounts for the session 1898-9.

Professor OSBORNE REYNOLDS, F.R.S., read a paper, entitled "**Notes on the Slipperiness of Ice.**"

This paper will be printed in full in the *Memoirs.*

Mr. C. L. BARNES read a paper, entitled "**Science in the Historical English Dictionary.**"

The first subject to engage our attention is Astrology, about which it is curious to notice that this word and 'Astronomy' have exchanged meanings since they were first

introduced. Two quotations, dated respectively 1581 and 1625, are given in proof of this statement, but the one most suitable for mention here is from Evelyn's 'Memoirs,' 1676, "Dined with me Mr. Flamsteed, the learned astrologer and mathematician, whom his Majesty had established in the new observatory in Greenwich Park." Now, Flamsteed, the first Astronomer Royal, was anything but an astrologer in our sense of the term. 'Astronomy' appears to have been the earlier word of the two in O.F. and M.F., however, with the meaning we now attach to astrology, but by the end of the 17th century the differentiation, as now understood, had become confirmed.

The first recorded introduction of the word 'Chemistrie' into literature is found in 1605. Within half a century it appears to have been held in very bad repute, for Gaule (1652) speaks of it as "a kind of praestigious cheating covetous magick," but this is mild compared with what was to follow in still more recent times. Praestigious, it may be remarked, means 'juggling' or 'cheating.' Thus Bentham, in his 'Chrestomathia' (1816) describes it in this fearful language: "Idioscopic or crypto-dynamic Anthropurgics has for its single-worded synonym the unexpressive appellation 'Chemistry.'"

Of a number of words which are more or less intimately connected with this great science, the word 'Alcohol' has perhaps the most curious history. The black native sulphide of antimony, termed by the Arabians 'kohl,' was, as is well known, in early use among Eastern ladies for purposes of adornment. Thus, in 2 Kings ix. 30, we read that Jezebel "put her eyes in paint," that is to say, in kohl, and there is a similar allusion in Ezekiel xxiii. 40. The custom has been remarked by travellers from the most remote times. Sandys (1615) says: "They put between the eyelids and the eye a certaine blacke powder made from a minerall brought from the kingdom of Fez, and called 'Alcohole.'" Bacon, in 1626, has a similar passage. But even as early as 1543 the word had begun to mean any fine impalpable powder, produced by trituration, or especially by sublimation, as *alcohol martis* for iron reduced from the oxide, *alcohol of sulphur* for

flowers of sulphur, and so on. So late as 1812, Davy, in his "Chemical Philosophy," says: "I have already referred to the alcohol of sulphur." But as this reference to the finely powdered state began to die out, so did the idea of sublimation, and, by an easy transference, that of distillation gradually usurped its place. For example, Libarius, in 1594, had already used the expression 'alcohol vini' for spirits of wine, and in the *Philosophical Transactions* for 1672 we find it in English as 'alcohol of wine.' In modern Spanish some of the older meanings are still in vogue; thus, 'Alcohol' in that language means either antimony or rectified spirits of wine; 'alcoholado,' spoken of cattle, means darker round the eyes than over the rest of the body, as though by the application of kohl; 'Alcoholador' means one employed in rectifying spirits, or who paints or dyes with antimony; 'Alcoholar,' most instructive of all, combines the three meanings, viz., to paint or dye with antimony, to rectify spirits, or to reduce to an impalpable powder. Once having touched upon antimony, we come upon another philological discussion in connection with that word itself. The remarks in the Dictionary are as follows: "Probably, like other terms of Alchemy, a corruption of some Arabic word re-fashioned so as to wear a Greek or Latin aspect; perhaps of the Arabic name uthmud, othmod, latinized as athimodium, atimodium, atimonium, antimonium. The earlier form of the Arabic is isthmid, in which Littré suggests an adaptation (quasi isthimmid) of the Greek *στίμμιδ-α*, a variant of *στίμμι*, whence also the Latin stibium. If this conjecture be substantiated, antimonium and stibium will be transformations of the same word." The word stibium, it may be remarked, comes directly from the Greek *στίμμι*, which means the same thing.

'Ammonia' has not been traced back previous to Bergman (1782), but ammoniac, armoniack, and several other variants are found centuries earlier. Thus Chaucer in the *Canon's Yeoman's Tale*, written about 1386, which, by the way, contains a large number of chemical terms, speaks of "Arsenick, sal-ammoniac, and brimstone."

Some very interesting references are found under the heading

'Atom.' This word has a quotation dated 1477, but up to the sixteenth century it was chiefly used in the Latin and Greek forms, atomus or atomos. These gradually gave way to the French form atome, and finally the terminal *e* was elided according to the ordinary English usage. Dalton's work in connection with this idea was, of course, in no sense etymological, hence one is not surprised to find that his name is only introduced incidentally under the heading 'Atomic.' The most curious meaning of the word 'atom' is undoubtedly that of a small interval of time, which appears to have been current in the dark ages.

From Van Helmont one very important item is gleaned, viz. that the word 'gas' is derived, not from the Dutch 'geest' as was previously thought, but from the Greek 'Χαος.' His own words are as follows: "Halitum illum 'gas' vocavi, non longe a Chao veterum secretum." The Dutch pronunciation of 'g' as a spirant accounts for its replacing the Greek χ. The principle meanings of chaos are void or empty space, and confusion, but Van Helmont does not enlighten us as to whether he saw in spirit the particles of a gas jostling one another and hurrying to and fro in hopeless disorder, or whether the apparent emptiness of the space occupied by gas led him to invent the word. This derivation appears to be a discovery of recent date, for even the Century Dictionary is not correct upon the point, although it quotes from the same source, "Ortus Medicinae," "Hunc spiritum, incognitum nactenus, novo nomine 'gas' voco." It therefore deserves to be more widely known, and this mention before our Society should assist in no small degree towards that end.

Ordinary Meeting, February 21st, 1899.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Dr. C. H. LEES read a paper, entitled "**Some preliminary Experiments on the Effect of Pressure on the Thermal Conductivity of Rocks.**"

This paper will be printed in full in the *Memoirs.*

A paper by the Right Reverend Bishop HANLON, of Uganda, entitled "**The Plague in Uganda,**" was read by Dr. Alfred Brown.

This paper will be printed in full in the *Memoirs.*

Special Meeting, February 28th, 1899.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The PRESIDENT said the meeting was held to present the Wilde Medal and the Wilde Premium awarded during this session.

The Council of the Society, by an unanimous vote, had awarded the Wilde medal this year to Sir Edward Frankland, K.C.B., F.R.S., for his chemical researches. Unfortunately, in consequence of the recent sudden death of Lady Frankland, Sir Edward was unable to carry out his intention to be present and receive the medal in person. From 1851 to 1856 he was Professor of Chemistry in the then recently established Owens College. He afterwards accepted the professorship of chemistry at St. Bartholomew's Hospital, and subsequently held a similar post at the Normal School of Science, South Kensington. Science owed much to him for his researches in pure and applied chemistry, and of these the President gave a brief outline. He asked the

Secretary to forward the medal to Sir Edward Frankland, with an expression of the Society's sympathy with him in his loss.

The Wilde Premium for 1899, the President proceeded to say, had been awarded to Dr. Charles H. Lees, in recognition of his successful researches in physics, more especially with regard to the thermal conductivities both of solids and liquids. They had watched with great interest his distinguished career at Owens College, which had culminated in 1895 in receiving the degree of Doctor of Science. They congratulated him on these distinctions, and wished him all success in the future.

Dr. LEES said he felt sure that in making the award to him the Council must have looked with a very lenient eye on any contributions he had made to the *Memoirs;* and he regarded it rather as an encouragement to future work than as a reward for anything he had done in the past. He proposed to use the premium as a fund on which he could draw for the purchase of apparatus which he might require in his future work.

Professor WILLIAM RAMSAY, F.R.S., then delivered the Wilde Lecture, entitled: "**On the newly-discovered Elements of the Air, and their Relation to the Kinetic Theory of Gases.**"

The Lecture will be printed in full in the *Memoirs.*

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General Meeting, March 7th, 1899.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

Mr. Charles Henry Crombie, B.A., Science Master, Hulme Grammar School; and Mr. Edgar Morris, B.A., 69, Shrewsbury Street, Old Trafford, were elected ordinary members of the Society.

Ordinary Meeting, March 7th, 1899.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Professor HORACE LAMB, F.R.S., read a paper, entitled **"A new version of Argand's Proof that every Algebraic Equation has a Root."**

This paper will be printed in full in the *Memoirs.*

Professor SCHUSTER exhibited some lantern slides, illustrating some researches made by himself and Mr. G. Hemsalech on the velocity of metallic molecules in the electric spark.

The results of these researches have been published in the *Philosophical Transactions* of the Royal Society.

When the spectrum of a spark between metallic poles is photographed on a film attached to a rapidly revolving wheel, the air-lines remain straight, though slightly broadened, while the metallic lines are seen to be inclined and curved. The velocity of the metallic molecules may be calculated from the measurement of the inclinations of the lines. In the case of zinc molecules the velocity was found to be about 500 m. per second. The metals of low atomic weight, *e.g.*, aluminium and magnesium, give higher velocities, while in the case of bismuth the different lines have different inclinations.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, October 17th, 1898.

MARK STIRRUP, F.G.S., President of the Section, in the Chair.

Mr. STIRRUP exhibited and described a large series of fossil corals from the Devonian and Carboniferous formations in the districts round Torquay.

Mr. BROADBENT exhibited limestone corals from the Ingleton district.

Mr. W. STANLEY exhibited and described a new form of microtome perfected by Mr. Aylward, with a fine adjustment capable of cutting sections $\frac{1}{500}$th of an inch in thickness.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, November 7th, 1898.

JOHN BOYD, Vice-President of the Section, in the Chair.

Mr. HYDE drew attention to the number of sparrows at Brooklands with white feathers occurring in the wing and tail and on the breast.

Mr. JOHN BUTTERWORTH described and exhibited under the microscopes a fungus attached to a fossil fern of the coal-measures, found by him in the Oldham district. It occurred in a fork of the fern and was recognised as being a fungus by the late Mr. Brittain; he drew attention to its similarity to the fungus known to attack the potato.

Mr. MULLEN presented the Section with 18 rock-sections for its cabinet of slides.

Mr. BOYD made a short communication on "Springtails." These little insects belong to the *Thysanura*. The Thysanura are divided into three families, 1. *Campodidæ*. 2. *Poduridæ*. 3. *Lepismidæ*. The "Springtails" are all included in the Poduridæ. This family again is divided into three tribes, 1. *Smynthuridæ*. 2. *Poduridæ*. 3. *Lipuridæ*. After describing

the chief charactistics of these three tribes, specimens of *Smynthurus*, *Lepidocyrtus*, *Macrotoma*, *Degeeria* and *Isotoma* were shown in illustration.

Special attention was called to the peculiar forked springer growing out of the antepenultimate joint of the abdomen, varying very much in size in the various species shown; to the ventral organ of attachment, which also sometimes acts as a retaining holder for the springer; and to the scales found on some species, but absent in others. The use of these scales as test objects for microscopical object glasses, and the vexed question of the true interpretation of what was seen, was alluded to.

Mr. Boyd expressed the opinion that the real character of the markings could only be ascertained by comparison of the markings on the scales of a series of different species.

Commencing with the *Lepisma* scale, he showed the longitudinal ribs to be on the upper surface of the scale, whilst on the lower surface there are cross ribs, and besides these there is a series of ribs running parallel to the rounded edge of the scale.

In *Macrotoma* the longitudinal folds or ribs are uniform and extend, at the lower edge, beyond the edge of the scale. The cross ribs at right angles show as dots, whilst the third set of ribs, very coarse, curved, and few in number, could only be seen in scales the surface of which had been obliterated by moisture.

In *Degeeria* the longitudinal ribs are very coarse, and are not continuous in height or thickness, and so give the appearance of marks of exclamation. The cross ribs are very faint, being only indicated by dots, and the third series of ribs is only seen near the margin of the scale.

In *Templetonia* the exclamation marks are very coarse.

In *Lepidocyrtus*, the so called Podura test scale, the markings are very much finer.

From this set of comparisons one can see that the exclamation marks, so difficult to show clearly under the microscope, are merely the longitudinal ribs or foldings of the upper urface of the scale. The cross ribs here again are indicated by small intermediate dots.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, December 5th, 1898.

MARK STIRRUP, F.G.S., President of the Section, in the Chair.

Mr. C. H. SCHILL exhibited collections of Australian *Cossidæ* and *Hepialidæ*.

Mr. J. COSMO MELVILL exhibited a very unusual variety of *Vanessa urticæ* Linn., in the fore-wings of which the whole of the six black spots and blotches, viz., the three bordering on the front costal margin and the three central blotches, are all suffused together by a semi-circular black-brown band, the innermost of the three costal blotches just mentioned above being still perceptible, while the red-brown system is restricted to a small central area extending through a narrow passage (the two parts of the semi-circular blotch) to the anal margin. The neuration passing through this red-brown area is also markedly black.

The hinder marginal blue spots are likewise absent, there being instead a cinereous black semi-transparency and suffusion. Hind-wings quite normal in every way.

The specimen was captured by the Rev. A. H. Melvill, M.A., at Freshwater, Isle of Wight, in 1889, and may be considered one of the most striking colour-aberrations of the small tortoiseshell butterfly yet discovered.

Mr. H. W. FRESTON exhibited a fine pair of *Dysdera crocota*, found near Bristol; a pair of *Trochosa cinerea*, captured in Montgomery last August, and a pair of *Tegenaria atrica* from Gloucestershire. These large spiders are rarely seen, owing to their remaining concealed during the day under stones along river banks; the last recorded specimens were found in 1836, in Yorkshire.

Mr. MARK SYKES exhibited and described specimens of the genus *Phrynus*, intermediate between scorpions and spiders.

Mr. J. R. HARDY exhibited specimens of *Phrygania maclachlania*, caddisflies from Japan.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, January 16th, 1899.

MARK STIRRUP, F.G.S., President of the Section, in the Chair.

Mr. J. COSMO MELVILL exhibited and described the series of the order *Ilicineæ* in his herbarium.

Mr. HENRY HYDE exhibited a collection of ferns from New Zealand and Australia.

Mr. THOMAS ROGERS exhibited specimens of *Helichrysum paronychioides*, one of the Compositæ, from the Orange Free State, and also cudweeds and grasses from Natal and Cape Colony.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, February 13th, 1899.

THOMAS ROGERS in the Chair.

Mr. JOHN WATSON exhibited under the microscopes living embryos of the Mexican Axolotl, *Menobranchus pisciformis* Harlan, showing circulation in the gills.

Mr. THOMAS ROGERS exhibited a collection of plants recently made in Ireland, including *Sisyrinchium angustifolium* and *S. californicum*, the latter being a species new to the British Flora.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, March 13th, 1899.

MARK STIRRUP, F.G.S., President of the Section, in the Chair.

Mr. M. SYKES and Mr. J. F. ALLEN were appointed Auditors.

Mr. ROGERS exhibited leaves of a North American plant, *Gelax*, also a stem of an Aloe with a large circular black fungus.

Mr. STIRRUP exhibited and described a large collection of silurian, devonian, and carboniferous corals.

[*Microscopical and Natural History Section.*]

Annual Meeting, April 10th, 1899.

MARK STIRRUP, F.G.S., President of the Section, in the Chair.

The Annual Report of the Council was read and adopted.

The following Officers and Council were elected for the session 1899-1900: President, CHARLES BAILEY, F.L.S.; Vice-Presidents, MARK STIRRUP, F.G.S., J. COSMO MELVILL, M.A., F.L.S., JOHN BOYD; Treasurer, G. H. BROADBENT, M.R.C.S.; Secretary, THEODORE SINGTON; Council, J. F. ALLEN, R. E. CUNLIFFE, W. E. HOYLE, M.A., M.Sc., HENRY HYDE, THOMAS ROGERS, MARK SYKES, F.R.M.S., C. H. SCHILL, JOHN WATSON.

Mr. BUTTERWORTH described and exhibited dendritic markings formed on paper labels about thirty years old, and presented a specimen for the cabinet of the Section.

Mr. JOHN WATSON read a paper on **Calinaga.**

Ordinary Meeting, March 21st, 1899.

J. COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Dr. C. H. LEES described the Wehnelt current-interrupter, and gave an account of some experiments he had made. The effect of substituting it for the mechanical make and break of an induction coil used for producing Röntgen rays is that the action of the Röntgen ray tube is intensified, but the anti-cathode is rapidly heated, and seemed in its hot state to be much less effective in producing the rays.

Mr. GEORGE WILSON, M.Sc., read a paper entitled **"Experiments on the Relation between Uniform Stress and Permanent Strain in Annealed Copper Bars and Wires."**

Messrs. F. H. Bowman, Stanton and Thorp took part in the discussion which followed.

This paper is printed in full in the *Memoirs*.

General Meeting, April 11th, 1899.

J. COSMO MELVILL, M.A., F.L.S., President, in the Chair.

Mr. Hardman A. Earle, Salford Iron Works, and Mr. O. V. Darbishire, B.A., Ph.D., Owens College, were elected ordinary members of the Society.

Ordinary Meeting, April 11th, 1899.

J. COSMO MELVILL, M.A., F.L.S., President, in the Chair.

Mr. JOHN WATSON read a paper entitled: "**On Calinaga, the Single Genus of an aberrant Sub-Family of Butterflies.**"

This paper is printed in full in the *Memoirs*.

Mr. F. J. FARADAY, F.L.S., read a paper entitled: "**On a Biological aspect of Cancer.**"

This paper is printed in full in the *Memoirs*.

Annual General Meeting, April 25th, 1899.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

On the recommendation of the Council, the following gentlemen were elected honorary members of the Society:—Mr. R. H. INGLIS PALGRAVE, F.R.S., F.S.S., and Professor WILLIAM RAMSAY, Ph.D., F.R.S.

The Annual Report (as amended) and the statement of Accounts were presented, and it was moved by Dr. F. H.

BOWMAN, seconded by Mr. G. H. BROADBENT, and resolved :—"That the Annual Report, together with the statement of accounts, be adopted, and be printed in the Society's *Proceedings*."

It was moved by Mr. JOHN BOYD, seconded by Mr. C. L. BARNES, and resolved :—"That the system of electing Associates of the Sections be continued during the ensuing session."

The following members were elected officers of the Society and members of the Council for the ensuing year :—

President: HORACE LAMB, M.A., F.R.S.

Vice-Presidents: OSBORNE REYNOLDS, M.A., LL D., F.R.S.; CHARLES BAILEY, F.L.S.; J. COSMO MELVILL, M.A., F.L.S.; W. BOYD DAWKINS, M.A., F.R.S.

Secretaries: R. F. GWYTHER, M.A.; FRANCIS JONES, F.R.S.E., F.C.S.

Treasurer: J. J. ASHWORTH.

Librarian: W. E. HOYLE, M.A., M.Sc.

Other Members of the Council: HAROLD B. DIXON, M.A., F.R.S.; FRANCIS NICHOLSON, F.Z.S.; J. E. KING, M.A.; R. L. TAYLOR, F.C.S.; F. J. FARADAY, F.L.S.; W. H. JOHNSON, B.Sc.

Ordinary Meeting, April 25th, 1899.

JAMES COSMO MELVILL, M.A., F.L.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Professor DIXON described an apparatus for bringing together nitrogen peroxide and nitric oxide in order to determine whether any combination occurs between the gases.

Annual Report of the Council, April, 1899.

The Society began the session with an ordinary membership of 152. During the present session 10 new members have joined the Society; 7 resignations have been received, and the deaths have been 5, viz.: Mr. Charles Lowe, F.C.S.; Mr. H. M. Ormerod, F.G.S.; Mr. R. M. Pankhurst, LL.D.; Mr. James Rhodes, F.R.C.S.; and Mr. John Wright. This leaves on the roll 150 ordinary members. The Society has also lost 5 honorary members by death, viz.: Professor Ferdinand Cohn, For. Mem. R.S.; Professor Sophus Lie, For. Mem. R.S.; Lord Playfair, G.C.B., F.R.S.; Mr. Osbert Salvin, M.A., F.R.S.; and Professor Gustav Wiedemann, For. Mem. R.S. Memorial notices of these gentlemen appear at the end of this report.

The Treasurer commenced the year with a balance in favour of the Society of £236. 10s. 7d. (including £44. 19s. 0d., balance of the Wilde Endowment Fund), and reports that the total balance, exclusive of the amount still owing by the Natural History Fund, but including the Wilde and Joule Funds, at the bankers and in hand, at the close of the year, of £140. 0s. 7½d.

The Treasurer reports that the session closing March 31st, 1899, has been an exceptionally expensive one to the Society. The necessary repairs to the Society's house and the new Bookcases required amounting to £65, with the large amount spent on bookbinding, will leave the balance at the Society's Bankers comparatively small, but as this expenditure will not be required again for many years, the Treasurer feels that the Society is in a favourable position financially.

The large amount spent on new Bookcases arose through an exceptional opportunity occurring from the sale by Owens

College of surplus shelving, which was acquired by the Society on very favourable terms.

During the year the Wilde Fund, consisting of £3,000 Consolidated 10 % Ordinary A Stock of the Gas Light and Coke Company, was exchanged for £7,500 4 % Ordinary Stock, in conformity with the Company's Act of Parliament.

The Council has printed in the *Memoirs* an abstract of the paper "On the Mechanical Equivalent of Heat," by Professor Osborne Reynolds and Mr. Moorby, published in the *Philosophical Transactions* of the Royal Society, and has charged the expense to the Joule Fund.

The re-cataloguing of the library has been continued during the session and substantial progress made, 11,275 volumes having been catalogued, stamped and pressmarked, 11,181 of these being serials, and 94 separate works. There have been written 2,193 catalogue cards; 2,040 for serials, and 153 for separate works. The total number of volumes catalogued to date is 20,019, for which 5,483 cards have been written. The books catalogued up to the present include the serial publications issued in Great Britain and Ireland, Denmark, Norway, Sweden, Holland, France, Spain, Portugal, Italy, Switzerland, Germany, Austria-Hungary, Russia, Greece, and India; also the separate works relating to Mathematics, Astronomy, Physics, Chemistry, Botany, Zoology, and Medicine.

During the session, 122 volumes have been borrowed from the library, as compared with 234 volumes in the previous session; it is hoped that, as the cataloguing progresses and affords increased facilities for quickly finding any work required, members will make further use of the valuable collection of books possessed by the Society.

Attention has again been paid to the completion of sets, with the result that 108 volumes or parts have been obtained which render 16 sets complete, whilst 57 volumes have been acquired which partly complete 12 sets. These 165 volumes,

with the exception of one purchased, were presented by the respective societies publishng them.

A considerable amount of binding has been done, 633 volumes having been bound in 549, and 125 volumes have undergone repair.

A record of the accessions to the library shows that, from April, 1898 to March, 1899, 665 serials and 54 separate works were received, a total of 719 volumes. By allowing for the 165 volumes obtained to complete sets, it will be seen that the normal increase to the library has been 554 volumes. The donations during the session (exclusive of the usual exchanges) amount to 50 volumes and 126 dissertations; 4 books have been purchased (in addition to the periodicals on the regular subscription list).

During the past session the Society has arranged to exchange publications with the following: American Mathematical Society, New York; *Astrophysical Journal*, Chicago; Augustana College, Rock Island; Buffalo Society of Natural Sciences; Gesellschaft Naturforschender Freunde, Berlin; Illinois State Laboratory of Natural History, Urbana; Instituto Geológico de México; K. K. Naturhistorisches Hofmuseum, Vienna; Linnean Society of New South Wales, Sydney; Museo Nacional de Montevideo; Philadelphia Commercial Museum; *Science Abstracts*, London; South African Museum, Cape Town; University of Toronto; Wisconsin Geological and Natural History Survey, Madison.

Through the co-operation of the Free Reference Library, the Owens College, the Manchester Museum, and the Conchological, Geographical, Geological, Medical, and Microscopical Societies, the Council was enabled to publish, in December last, a "List of the Current Scientific Serial Publications received by the Principal Libraries of Manchester," which includes the serials received by the above-mentioned institutions as well as those taken by this Society.

At the request of the Council, the President accepted the position of delegate to the Fourth International Congress of Zoology, held at Cambridge, August 23-27, 1898.

The University of Cambridge having requested the Society to take part in the proceedings on June 1 and 2, 1899, to celebrate the Jubilee of Sir George Gabriel Stokes, Bart., as Lucasian Professor of Mathematics, the Council has nominated Mr. R. F. Gwyther, one of the Secretaries, as delegate to represent the Society on the occasion.

The Council has awarded :—

The Wilde Medal for 1899 to Sir Edward Frankland, K.C.B., F.R.S., for the great services he has rendered to science by his researches in pure and applied chemistry;

The Wilde Premium for 1899 to Mr. Charles H. Lees, D.Sc., for a series of papers on the subject of thermal conductivity, communicated to the Society.

Professor William Ramsay, F.R.S., was appointed to deliver the Wilde Lecture.

The Medal and Premium were presented and the Wilde Lecture was delivered on Tuesday, February 28th, 1899.

By the death of FERDINAND JULIUS COHN on the 25th of June, 1899, the Society lost a most distinguished honorary member. Born in Breslau in 1828 Cohn, after studying both in his native town and at the University of Berlin, became Privatdocent in Breslau in 1856, Extraordinarius in 1859 and ordinary Professor in 1872. But though his life was thus confined to the Silesian capital, his name and his work were familiar to all botanists. His tastes inclined him particularly to the study of minute organisms, chiefly algæ and fungi, and his investigations on these two groups of plants led to the publication of his very important "Beitraege zur Biologie der Pflanzen" commenced in 1870 and brought to a conclusion in 1896. Besides numerous separate memoirs on various cryptogamic plants he was also responsible for the "Kryptogamen Flora von Schlesien"

published (1876-94) by the Schlesische Gesellschaft für vaterländische Kultur. His singular ability as a popular lecturer is evident from a perusal of his collected lectures in "Die Pflanze." In these he has related in fascinating way and in simple language the results of many botanical investigations, including many of his own observations, and has described some of the problems still awaiting solution. Cohn was elected Foreign Member of the Linnean Society of London in 1876 and awarded the Linnean Medal in 1895.

He was elected Honorary Member of the Manchester Literary and Philosophical Society on April 30, 1889.

A year before his death, on the occasion of the jubilee of his doctorate, he had conferred upon him the freedom of the city of Breslau, his native town.

A fuller account of his life and work will be found in the *Proceedings of the Linnean Society of London* (Oct. 1899).

F. E. W.

The distinguished Norwegian mathematician, SOPHUS LIE, died at Christiania on the 18th of February, 1899.

Professor Lie was born at Nordfjordeid at the end of 1842. After graduating at Christiania, he held an appointment as extraordinary professor there, till he was called, in 1886, as ordinary professor to Leipsic. Just before his death he returned to Christiania to fill a specially created chair.

The number of mathematical papers by Lie is very large, and shew great originality and masterly skill. The subject which he developed and with which the greater part of his work is concerned is the theory of continuous Transformation-groups and in particular that of tangential transformations. The purposes to which Lie applied this theory are very varied. Although in the first place a geometrical theory, perhaps the most successful application was to the theory of Differential Equations.

The originality and wide extent of his labours have provided a field for the many workers whom his genius has inspired, and

the fundamental character of his investigations and methods make his fame secure.

Fuller details of his work can be found in the *Comptes Rendus*, February 27, 1899.

Lyon Playfair, son of Dr. George Playfair, Chief Inspector-General of Hospitals for the Presidency of Bombay, was born in Meerut on 21st May, 1819. His early education was obtained at St. Andrews, where his grandfather had been Principal of the United College. When fifteen Lyon Playfair went to Glasgow to study medicine, but was attracted to chemistry by the teaching of Thomas Graham. After a short visit to India he returned to England, and studied chemistry under Graham, who had meantime been appointed Professor at University College, London.

At the age of nineteen Playfair began work under Liebig, at Giessen, and after two years published his first paper. When Liebig came to England on the invitation of the Prince Consort to lecture on "Agricultural Chemistry," Playfair accompanied him as assistant and interpreter, and thus obtained an introduction to the Prince.

For some two years Playfair managed the chemical department of Messrs. Thomson's print works, at Clitheroe. In 1843 he was appointed Professor of Chemistry at the Royal Institution, Manchester. The writer has heard Playfair describe the emotion he felt when the venerable Dr. Dalton came to hear him lecture. At Manchester, Playfair joined hands with Joule in a series of researches on "Atomic Volume and Specific Gravity," printed in the early memoirs of the Chemical Society, of which Playfair was an original member.

In 1846 Playfair was appointed Professor of Chemistry in the School of Mines; in 1858 he was appointed Professor of Chemistry in the University of Edinburgh, where he not only greatly improved the laboratory and practical teaching, but was largely instrumental in securing the introduction of degrees in

science. In 1868 Playfair first entered Parliament and sat in the Commons till he was raised to the Peerage in 1892.

In 1844 Playfair began his official work for the Government by serving on the Royal Commission on the sanitary condition of large towns. He was special commissioner for the 1851 Exhibition; then one of the joint secretaries of the Science and Art Department which grew out of the Exhibition, and Inspector-General of Government Museums and Schools of Science.

The most important scientific work published by Playfair was that done in collaboration with Joule on "Atomic Volumes," and his papers on "Catalytic Action" and "The Nitro-prussides." He himself used to declare that the greatest discovery in pure science that he had made was the discovery of Frankland and Dewar. But Playfair brought science to bear on many important practical problems, and the position taken to-day by science and scientific men in England is largely due to Playfair's activity and influence.

He was elected an Honorary Member of this Society on April 29, 1851, and his death occurred in London, on May 29, 1898. H. B. D.

Osbert Salvin, F.R.S., who died on the 1st of June, 1898, at his home, Hawksfold, near Haslemere, in Sussex, was born at Finchley in 1835, and was the second and only surviving son of the late Mr. Anthony Salvin, the well-known architect. Shortly after graduating at Cambridge as Senior Optime in the Mathematical Tripos of 1857, he made a Natural History Expedition to Tunis and Algeria, in the company of Mr. W. H. Hudleston and Canon Tristram, both of whom survive him. In the autumn of the same year he made the first expedition to Guatemala, a country with which his life's work was to be largely associated, where he stayed chiefly in company with the late Mr. G. U. Skinner, the well-known collector of orchids, till the middle of 1858, revisiting the same region in about a year, and for a third time in 1861, in company with his friend and future coadjutor, Mr. F. D. Godman. After

his marriage, in 1865, he with his wife made a fourth journey to Central America. Mr. Salvin was a lepidopterist of note as well as an ornithologist, and these expeditions in Tropical America furnished him with material not only for the monumental work, the *Biologia Centrali-Americana*, but for the remarkable and numerous series of papers published subsequently on the ornithology of Central and South America in *The Ibis*, the *Proceedings of the Zoological Society of London*, and the British Museum *Catalogue of Birds.* It is quite impossible in this short notice to do justice to the work accomplished by Mr. Salvin, but this may be truly said—that he was an almost unrivalled "all round" ornithologist and his name will ever remain amongst the most prominent of those who have made this rich field the special subject of life-long research. He was elected an Honorary Member of this Society on April 26, 1892. Fuller notices of his life are to be found in the *Proceedings of the Royal Society*, vol. 64, pp xiii.-xvii.; the *Auk*, vol. 15, pp. 343-5, and the *Ibis*, 1898, pp. 626-7. F. N.

By the death, on the 23rd March, 1899, of GUSTAV HEINRICH WIEDEMANN, Professor of Physics at the University of Leipsic, the Society has lost one of the most distinguished and widely known of its honorary members. He was born at Berlin, on the 2nd October, 1826, and, after losing his parents at an early age, was brought up by his grandparents. He received his early education at the Köllnisches Real-gymnasium at Berlin, and in 1844 entered as a student at the University, determined, as he himself has stated, "to study thoroughly as auxiliary subjects Mathematics and Chemistry, and then to devote himself to Physics." After studying under Mitscherlich, Dirichlet, and Magnus, and after receiving his Docentship in 1851, he married Clara Mitscherlich, and in 1854 he was appointed Professor of Physics at Basle. After nine years of active scientific work he was removed to Brunswick, again in 1866 to the Hochschule at Carlsruhe, and finally in 1871 to the University of Leipsic, where he remained till his death. His

health, which had shown signs of failing in 1895, began again to trouble him in 1898, and he had made arrangements for retiring when death overtook him.

His scientific work was carried out mainly in the field of Magnetism and Electricity, in which he made the subject of the the magnetisation of bodies his particular study. He made one of the earliest determinations of the Ohm, made observations on the electromagnetic solution of the plane of polarisation of light just discovered by Faraday, and was the first to call attention to the relation between the conductivities of the metals for heat and for electricity. The great work of his scientific life was, however, the publication in 1861 of his "*Lehre vom Galvanismus und Elektromagnetismus*," since called "*Die Lehre von der Elektricität*," and the incorporation in its successive editions of the results of further research. The fourth edition, which he was able to complete before his death, will remain for years a monument to his industry and critical powers.

Wiedemann was one of the oldest members of the Berlin Physical Society, and was from 1877 to his death the editor of the *Annalen der Physik*. He joined to a rapid comprehension of a subject the power of giving a clear exposition of it, was most courteous in debate, and a good correspondent. He was present at the British Association meeting in Manchester in 1887, taking a prominent part in the work of the Mathematical and Physical Section.

Further particulars of his work can be found in the *Verhandl. der Deutsch. Phys. Gesell.*, 30th June, 1899.

C. H. L.

Henry Mere Ormerod, who died on the 26th June, 1898, in the 83rd year of his age, had been in continuous membership with the Society for the long period of fifty-five years, the date of his election being 30th April, 1844. He belonged to an old north-country family which has produced a long line of scholars, theologians, historians, and naturalists, who have left their mark upon the literature of this and neighbouring counties. His

father, Dr. George Ormerod, was the learned author of "The History of Cheshire," and Henry Mere Ormerod was the fourth, and last survivor, of his seven sons.

He was born in London, on the 10th of January, 1816. He was a pupil of Dr. Arnold's, at Rugby, where he met among his schoolfellows many who became men of mark in after years. Upon leaving school he embraced the profession of the law, and through the circumstance of his being articled to a firm of Manchester solicitors, he became a resident, and to the close of his life he identified himself with the scientific, artistic, and literary life of the district. For many years he acted as the Society's solicitor, and in that capacity was instrumental in effecting its incorporation: some of the older members will recall the precision, in every detail, with which its various stages were carried through, Mr. Ormerod being almost pedantic in the strict observance of all that was necessary legally, as well in the council as in the general meetings of the members.

Mr. Ormerod was at one time president of the Manchester Geological Society, and, prior to his death, was the last surviving founder of that society. He also gave considerable time to the affairs of the Royal Institution, in Mosley Street; he was its honorary secretary for several years, and was its president at the time when it passed into the hands of the corporation of the city. He was a fine man physically, and he attended to his professional duties until the close of his life. He had a great fund of humour, which, though subdued, was effective and good-natured; his stories of a bygone generation and of the men he had met throughout his long life making him a most enjoyable companion.

C. B.

Richard Marsden Pankhurst, who joined the Society on February 23, 1892, was the only son of Mr. F. H. Pankhurst, a well-known auctioneer in Manchester. He was educated at the Manchester Grammar School, and at the Owens College, which he entered in 1855, taking the courses of study arranged for the University of London, and graduating B.A. in 1858, and

LL.B., with honours, in the following year. In 1863 he was made LL.D., and awarded the gold medal. After practising for a short time as a solicitor, Dr. Pankhurst was called to the Bar at Lincoln's Inn in 1867, and subsequently practised on the Northern Circuit and in the Palatine Chancery Court. As a jurist Dr. Pankhurst took a high place, and had not politics occupied his time to such a considerable extent, he would undoubtedly have achieved the highest distinction in the theoretical branches of legal science. As it is, he had a large share in the scheme for the reform of the Patent Laws in 1866, and published various addresses and essays of importance on questions of scientific jurisprudence and legal reform. Amongst these may be named "Local Courts and Tribunals," "International Law," "Arbitration," and "Systematic Study of the Law." Dr. Pankhurst began his professional career during one of the transition periods of English law, when it is suddenly realised that the historical methods and ideas so long in vogue have ceased to be in agreement with the times. At such a time the danger is that a policy of compromise between the new and old will end in confusion and complications. Dr. Pankhurst, who was ever among the extreme reformers, was sure to attract attention at such a time, and by the boldness of his ideas, and the clearness of his views, had a very great influence on current thought. He was a prominent member of the now defunct Social Science Association, and as a member of the Manchester Chamber of Commerce paid great attention to questions of Commercial Law. Dr. Pankhurst also took very keen interest in the education movement, and was from 1863 to 1876 honorary secretary of the Union of Lancashire and Cheshire Institutes. He made three unsuccessful attempts to enter Parliament, as a Liberal at Manchester in 1883, and at Rotherhithe in 1885, while in 1895 he stood as a representative of the Independent Labour Party at Gorton. In 1879 he married Miss Emmeline Goulden, of Seedley. However great the public disfavour his extreme views gained him, his brilliant ability as a speaker and a thinker, and the charm and kindliness of his manners in private,

never failed to secure for him the personal regard of those who met him. Into all work with which he was concerned Dr. Pankhurst threw an extraordinary amount of vigour, his temperament being undoubtedly conducive to his untimely decease. Dr. Pankhurst was an Associate and a Governor of the Owens College. He died on July 5th, 1898.

W. B. F.

James Rhodes, F.R.C.S., who was born at Tintwistle in 1830, died at Glossop in his sixty-ninth year, on April 21, 1898. Dr. Rhodes commenced his medical practice at Milltown, but subsequently succeeded to the practice of his relative, Dr. Turton, under whom he had originally served at Glossop. His private practice was large, and extended widely through the High Peak, and the duties of the appointment of Medical Officer were discharged by him for many years. Dr. Rhodes was also one of the earliest members of the Glossop Town Council. During a very busy life he kept up a continual interest in both literary and scientific subjects, and was the author of several papers and articles marked by a clear philosophical spirit, and his annual reports on sanitary and medical matters were highly esteemed, and his attendance at the meeting of the Society was frequent. Dr. Rhodes' manner was markedly genial, kindly, and courteous, and his loss is deplored by all who knew him. His wife died in 1882, and he leaves three sons and a daughter. He was elected a member of this Society on April 3, 1883.

Mr. John Wright was connected with the Society for all too brief a period, his election to membership dating from 20th October, 1896. Though not himself an original investigator, he was always alert to utilise the investigations of others by putting their conclusions to practical tests. He belonged to a Derbyshire family, but was born at Cheetham Hill, on the 18th November, 1844, and was educated at the Cheetham Collegiate School. In his early years he became connected with the large manufacturing, home-trade, and shipping firm of

Messrs. John Rylands & Sons, Ltd., ultimately becoming one of its directors. He threw all his energies into bringing the various departments which he superintended into the highest state of efficiency, by adopting all the latest improvements, and infusing much of his strong common sense into those who carried out his instructions. Up to the period of his death he was the chairman of the Dyers' and Bleachers' Association of the Manchester District. A good portion of his limited leisure was spent as honorary secretary to the Penitentiary in Embden Street, which for many years had the benefit of his wide experience in the machinery used in the industrial work of that institution, and in strengthening its finances. He interested himself also in the work of the Hulme Dispensary, and in instituting the Manchester Lifeboat Saturday Fund. In private life he was the soul of honour, most genial in his address, and a thorough friend. His early and unexpected death took place in his 54th year, on the 27th August, 1898.

C. B.

MANCHESTER LITERARY AN

Dr. *J. J. Ashworth, Treasurer, in Account with*

	£ s. d.	£ s.
To Cash in hand, April 1st, 1898		191 11
To Members' Subscriptions:—		
Half Subscriptions, 1898-99, 8 at £1. 1s. 0d.	8 8 0	
Subscriptions:— 1896-97, 1 at £2. 2s. 0d.	2 2 0	
" 1897-98, 17 " "	35 14 0	
" 1898-99, 112 " "	235 4 0	
" 1899-1900, 1 " "	2 2 0	
		283 10
To Wilde Endowment Fund:—		
Half Subscriptions, 1898-99, 8 at £1. 1s. 0d	8 8 0	
Subscriptions, 1898-99, 2 " £2. 2s. 0d.	4 4 0	
Admission Fees	12 12 0	
		25 4
To Donation:—		
G. A. James Rothney, Esq.		2 12
To Contributions from Sections:—		
Microscopical and Natural History Section, 1898-99	5 5 0	
Physical and Mathematical Section, 1898-99	2 2 0	
		7 7
To Use of the Society's Rooms:—		
Transfer from Wilde Endowment Fund, 1898-99		50 0
To Sale of Publications		19 3
To Dividends:—		
Natural History Fund	59 4 2	
Joule Memorial Fund	7 9 10	
		66 14
To Income Tax Refunded:—		
Natural History Fund	2 0 10	
Joule Memorial Fund	0 5 0	
		2 5
To Bank Interest		1 5
		£649 13

1899.—April 1. To Cash in Williams Deacon and Manchester & Salford Bank, and in hand . £65 0

WILDE ENDOWMEN

	£ s.
To Balance from 1897-98	44 19
To Dividends on £3,000 Gas Light and Coke Company's Ordinary (A) Stock	355 5
To Remission of Income Tax, 1898	12 10
To Bank Interest	1 1
	£413 15 1

NATURAL HISTORY

	£ s. d.
To Dividends on £1,225 Great Western Railway Company's Stock	59 4 2
To Remission of Income Tax, 1898	2 0 10
To Balance against this Fund, April 1st, 1899	100 13 11
	£161 18 11

JOULE MEMORIAL

	£ s. d.
To Balance, April 1st, 1898	30 15 0
To Dividends on £258 Loan to Manchester Corporation	7 9 10
To Remission of Income Tax, 1898	0 5 0
	£38 9 10

HILOSOPHICAL SOCIETY.

ciety, from 1st April, 1898, to 31st March, 1899. **Cr.**

	£ s. d.	£ s. d.
Charges on Property :—		
Chief Rent (Income Tax deducted)	12 9 8	
Income Tax on Chief Rent	0 8 7	
Insurance against Fire	13 17 6	
Repairs to Building, &c.	12 4 4	
Joule Thermometer Case	5 5 0	
Bookcases for Library	53 0 0	
		97 5 1
House Expenditure :—		
Coals, Gas, Electric Light, Water, Wood, &c.	37 8 6	
Tea, Coffee, &c., at Meetings	9 16 7	
Cleaning, Sweeping Chimneys, &c.	2 4 6½	
		49 9 7½
Administrative Charges :—		
Housekeeper	63 12 0	
Postages, and Carriage of Parcels and of "Memoirs"	40 0 1	
Stationery, Cheques, Receipts, and Engrossing	6 14 0	
Printing Circulars, Reports, &c.	12 13 3	
Miscellaneous Expenses	1 3 6½	
		124 2 10½
Publishing :—		
Honorarium for Editing the "Memoirs," 1898-9	50 0 0	
Printing "Memoirs and Proceedings" (less amount charged to Joule Fund)	102 4 0	
Printing "List of Scientific Serials in Manchester"	19 0 0	
Wood Engraving and Lithography (except Natural History Plates)	9 13 3	
		180 17 3
Library :—		
Books and Periodicals (except on Natural History)	40 12 8	
Library Appliances	6 14 6	
Subscription of Delegate to the International Congress of Zoology	2 2 0	
		49 9 2
Natural History Fund :—		
(Items shown in the Balance Sheet of this Fund)		68 7 1
Joule Memorial Fund :—		
(Item shown in the Balance Sheet of this Fund)		15 2 0
Balance at Bank	60 0 8	
,, in Treasurer's hands	5 0 0½	
		65 0 8½
		£649 13 9½

UND, 1898—1899.

	£ s. d.	£ s. d.
Assistant Secretary's Salary, April, 1898, to March, 1899		121 10 0
Maintenance of Society's Library :—		
Binding and Repairing Books	87 18 2	
Book Supports	3 11 0	
		91 9 2
Gold Medal and Engraving Same		18 19 6
Wilde Premium for Selected Memoir		15 15 0
Premium to Lecturer		15 15 0
Transfers to the Society's Funds :—		
Subscriptions of Members	12 12 0	
Entrance Fees	12 12 0	
Use of Society's Rooms	50 0 0	
		75 4 0
Cheque Book		0 2 6
Balance at Bank, April 1st, 1899		74 19 11
		£413 15 1

UND, 1898—1899.

	£ s. d.
Balance against, April 1st, 1898	93 11 10
Natural History Books and Periodicals	37 1 1
Plates for Papers on Natural History in "Memoirs"	31 6 0
	£161 18 11

UND, 1898—1899.

	£ s. d.
Printing Reynolds and Moorby's Paper "On the Mechanical Equivalent of Heat'	15 2 0
Balance, April 1st, 1899	23 7 10
	£38 9 10

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Dr. *J. J. Ashworth, Treasurer, in Account with the Society, from 1st April, 1898, to 31st March, 1899.* **Cr.**

Dr.	£ s. d.	£ s. d.
To Cash in hand, April 1st, 1898		191 11 7
To Members' Subscriptions :—		
Half Subscriptions, 1898-99, 8 at £1. 1s. od.	8 8 0	
Subscriptions :— 1896-97, 1 at £2. 2s. od.	2 2 0	
" 1897-98, 17 " "	35 14 0	
" 1898-99, 112 " "	235 4 0	
" 1899-1900, 1 " "	2 2 0	
		283 10 0
To Wilde Endowment Fund :—		
Half Subscriptions, 1898-99, 8 at £1. 1s. od	8 8 0	
Subscriptions, 1898-99, 2 " £2. 2s. od.	4 4 0	
Admission Fees	12 12 0	
		25 4 0
To Donation :—		
G. A. James Rothney, Esq.		2 12 6
To Contributions from Sections :—		
Microscopical and Natural History Section, 1898-99	5 5 0	
Physical and Mathematical Section, 1898-99	2 2 0	
		7 7 0
To Use of the Society's Rooms :—		
Transfer from Wilde Endowment Fund, 1898-99		50 0 0
To Sale of Publications		19 3 4½
To Dividends :—		
Natural History Fund	59 4 2	
Joule Memorial Fund	7 9 10	
		66 14 0
To Income Tax Refunded :—		
Natural History Fund	2 0 10	
Joule Memorial Fund	0 5 0	
		2 5 10
To Bank Interest		1 5 6
		£649 13 9½

1899.—April 1. To Cash in Williams Deacon and Manchester & Salford Bank, and in hand . £65 0 8½

Cr.	£ s. d.	£ s. d.
By Charges on Property :—		
Chief Rent (Income Tax deducted)	12 9 8	
Income Tax on Chief Rent	0 8 7	
Insurance against Fire	13 17 6	
Repairs to Building, &c.	12 4 4	
Joule Thermometer Case	5 5 0	
Bookcases for Library	53 0 0	
		97 5 1
By House Expenditure :—		
Coals, Gas, Electric Light, Water, Wood, &c.	37 8 6	
Tea, Coffee, &c., at Meetings	9 16 7	
Cleaning, Sweeping Chimneys, &c.	2 4 6½	
		49 9 7½
By Administrative Charges :—		
Housekeeper	63 12 0	
Postages, and Carriage of Parcels and of "Memoirs"	40 0 1	
Stationery, Cheques, Receipts, and Engrossing	6 14 0	
Printing Circulars, Reports, &c.	12 13 3	
Miscellaneous Expenses	1 3 6½	
		124 2 10½
By Publishing :—		
Honorarium for Editing the "Memoirs," 1898-9	50 0 0	
Printing "Memoirs and Proceedings" (less amount charged to Joule Fund)	102 4 0	
Printing "List of Scientific Serials in Manchester"	19 0 0	
Wood Engraving and Lithography (except Natural History Plates)	9 13 3	
		180 17 3
By Library :—		
Books and Periodicals (except on Natural History)	40 12 8	
Library Appliances	6 14 6	
Subscription of Delegate to the International Congress of Zoology	2 2 0	
		49 9 2
By Natural History Fund :—		
(Items shown in the Balance Sheet of this Fund)		68 7 1
By Joule Memorial Fund :—		
(Item shown in the Balance Sheet of this Fund)		15 2 0
By Balance at Bank	60 0 8	
" " in Treasurer's hands	5 0 0½	
		65 0 8½
		£649 13 9½

WILDE ENDOWMENT FUND, 1898—1899.

Dr.	£ s. d.
To Balance from 1897-98	44 19 0
To Dividends on £3,000 Gas Light and Coke Company's Ordinary (A) Stock	355 5 0
To Remission of Income Tax, 1898	12 10 0
To Bank Interest	1 1 1
	£413 15 1

Cr.	£ s. d.	£ s. d.
By Assistant Secretary's Salary, April, 1898, to March, 1899		121 10 0
By Maintenance of Society's Library :—		
Binding and Repairing Books	87 18 2	
Book Supports	3 11 0	
		91 9 2
By Gold Medal and Engraving Same		18 19 6
By Wilde Premium for Selected Memoir		15 15 0
By Premium to Lecturer		15 15 0
By Transfers to the Society's Funds :—		
Subscriptions of Members	12 12 0	
Entrance Fees	12 12 0	
Use of Society's Rooms	50 0 0	
		75 4 0
By Cheque Book		0 2 6
By Balance at Bank, April 1st, 1899		74 19 11
		£413 15 1

NATURAL HISTORY FUND, 1898—1899.

Dr.	£ s. d.
To Dividends on £1,225 Great Western Railway Company's Stock	59 4 2
To Remission of Income Tax, 1898	2 0 10
To Balance against this Fund, April 1st, 1899	100 13 11
	£161 18 11

Cr.	£ s. d.
By Balance against, April 1st, 1898	93 11 10
By Natural History Books and Periodicals	37 1 1
By Plates for Papers on Natural History in "Memoirs"	31 6 0
	£161 18 11

JOULE MEMORIAL FUND, 1898—1899.

Dr.	£ s. d.
To Balance, April 1st, 1898	30 15 0
To Dividends on £258 Loan to Manchester Corporation	7 9 10
To Remission of Income Tax, 1898	0 5 0
	£38 9 10

Cr.	£ s. d.
By Printing Reynolds and Moorby's Paper "On the Mechanical Equivalent of Heat"	15 2 0
By Balance, April 1st, 1899	23 7 10
	£38 9 10

NOTE.—The Treasurer's Accounts of the Session 1898-99 of which the foregoing pages are summaries, have been endorsed as follows:

April 24th, 1899. Audited and found correct.

We have also seen, at this date, the certificates of the following Stocks held in the name of the Society:—£1,225 Great Western Railway Company 5% Consolidated Preference Stock, Nos. 12,293, 12,294, and 12,323; £258 Twenty years' loan to the Manchester Corporation, redeemable 25th March, 1914 (No. 1564); £7,500 Gas Light and Coke Company Ordinary Stock, (No. 6389); and the Deeds of the Natural History Fund, of the Wilde Endowment Fund, those conveying the land on which the Society's premises stand, and the Declaration of Trust.

(Signed) { THOMAS THORP.
H. W. FRESTON.

THE COUNCIL

AND MEMBERS

OF THE

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

(Corrected to April 25th, 1899.)

President.

HORACE LAMB, M.A., F.R.S.

Vice-Presidents.

OSBORNE REYNOLDS, M.A., LL.D., F.R.S.
CHARLES BAILEY, F.L.S.
JAMES COSMO MELVILL, M.A., F.L.S.
W. BOYD DAWKINS, M.A., F.R.S.

Secretaries.

R. F. GWYTHER, M.A.
FRANCIS JONES, F.R.S.E., F.C.S.

Treasurer.

J. J. ASHWORTH.

Librarian.

W. E. HOYLE, M.A., M.Sc., M.R.C.S.

Of the Council.

HAROLD B. DIXON, M.A., F.R.S.
FRANCIS NICHOLSON, F.Z.S.
J. E. KING, M.A.
R. L. TAYLOR, F.C.S.
F. J. FARADAY, F.L.S.
W. H. JOHNSON, B.Sc.

ORDINARY MEMBERS.

Date of Election.

1870, Dec. 13. Angell, John, F.C.S., F.I.C. 6, *Beaconsfield*, *Derby Road*, *Withington*, *Manchester.*

1896, Jan. 21. Armstrong, Frank. *The Rowans*, *Harboro' Grove*, *Harboro' Road*, *Ashton-on-Mersey*, *Cheshire.*

1895, Jan. 8. Armstrong, Geo. B. *Clarendon*, *Sale*, *Cheshire.*

1887, Nov. 16. Ashworth, J. Jackson. 39, *Spring Gardens*, *Manchester.*

1865, Nov. 14. Bailey, Charles, F.L.S. *Ashfield*, *College Road*, *Whalley Range*, *Manchester.*

1888, Feb. 7. Bailey, Alderman Sir W. H. *Sale Hall*, *Sale*, *Cheshire.*

1895, Jan. 8. Barnes, Charles L., M.A. 10, *Nelson Street*, *Chorlton-on-Medlock*, *Manchester.*

1894, Jan. 9. Beckett, J. Hampden, F.C.S. *Corbar Hall*, *Buxton.*

1896, April 14. Behrens, George B. *The Acorns*, 4, *Oak Drive*, *Fallowfield*, *Manchester.*

1895, Mar. 5. Behrens, Gustav. *Holly Royde*, *Withington*, *Manchester.*

1898, Nov. 29. Behrens, Walter L. 22, *Oxford Street*, *Manchester.*

1868, Dec. 15. Bickham, Spencer H., F.L.S. *Underdown*, *Ledbury.*

1896, April 14. Bindloss, James B. *Elm Bank*, *Eccles*, *Lancs.*

1896, April 28. Bolton, Herbert, F.R.S.E. *The Museum*, *Bristol.*

1861, Jan. 22. Bottomley, James, D.Sc., B.A., F.C.S. 220, *Lower Broughton Road*, *Manchester.*

1896, Oct. 6. Bowman, F. H., D.Sc., F.R.S.E. *Mayfield*, *Knutsford*, *Cheshire.*

1896, Feb. 18. Bowman, George, M.D. 594, *Stretford Road*, *Old Trafford*, *Manchester.*

1875, Nov. 16. Boyd, John. *Barton House*, *Didsbury Park*, *Didsbury*, *Manchester.*

1889, Oct. 15. Bradley, Nathaniel, F.C.S. *Sunnyside*, *Whalley Range*, *Manchester.*

1894, Mar. 6. Broadbent, G. H., M.R.C.S. 8, *Ardwick Green*, *Manchester.*

1896, Nov. 17. Broderick, Lonsdale, F.C.A. *Somerby*, *Wilmslow*, *Cheshire.*

1861, April 2. Brogden, Henry, F.G.S., M.Inst.M.E. *Hale Lodge*, *Altrincham*, *Cheshire.*

1889, April 16. Brooks, Samuel Herbert. *Slade House*, *Levenshulme*, *Manchester.*

1844, Jan. 23. Brooks, Sir William Cunliffe, Bart., M.A. *Bank*, 92, *King Street*, *Manchester.*

1860, Jan. 24. Brothers, Alfred, F.R.A.S. 78, *King Street*, *Manchester*

Date of Election.

1886, April 6. Brown, Alfred, M.A., M.D. *Sandycroft, Higher Broughton, Manchester.*

1846, Jan. 27. Browne, Henry, M.A. (Glas.), M.R.C.S. (Lond.), M.D. (Lond.) *The Gables, Victoria Park, Manchester.*

1889, Jan. 8. Brownell, T. W., F.R.A.S. 64, *Upper Brook Street, Manchester.*

1889, Oct. 15. Budenberg, C. F., M.Sc., M.Inst.M.E. *Bowdon Lane, Marple, Cheshire.*

1872, Nov. 12. Burghardt, Charles Anthony, Ph.D. 35, *Fountain Street, Manchester.*

1896, Nov. 3. Burke, John, B.A. *Owens College, Manchester.*

1894, Nov. 13. Burton, Wm., F.C.S. *The Hollies, Clifton Junction, near Manchester.*

1893, Jan. 10. Chadwick, W. I. 26, *King Street, Manchester.*

1899, Feb. 7. Chapman, D. L., B.A. *Owens College, Manchester.*

1854, April 18. Christie, Richard Copley, M.A., *Ribsden, near Bagshot, Surrey.*

1895, April 9. Claus, Wm. H. 31, *Mauldeth Road, Fallowfield, Manchester.*

1895, April 30. Collett, Edward Pyemont. 7, *Wilbraham Road, Chorlton-cum-Hardy, Manchester.*

1884, Nov. 4. Corbett, Joseph. *Town Hall, Salford.*

1895, April 30. Cornish, James Edward. *Stone House, Alderley Edge, Cheshire.*

1859, Jan. 25. Coward, Edward, Assoc.Inst.C.E., M.Inst.M.E. *Heaton House, Heaton Mersey, near Manchester.*

1899, Mar. 7. Crombie, Charles H., B.A. 163, *Chorlton Road, Brooks's Bar, Manchester.*

1895, Nov. 12. Crossley, Wm. J., M.Inst.M.E. *Openshaw, Manchester.*

1896, Nov. 3. Crowther, J., A.R.S.M. *Technical School, Swansea.*

1876, April 18. Cunliffe, Robert Ellis. *Halton Bank, Pendleton, Manchester.*

1899, April 11. Darbishire, O. V., B.A., Ph.D. *Owens College, Manchester.*

1853, April 19. Darbishire, Robert Dukinfield, B.A., F.S.A. 1, *St. James's Square, Manchester.*

1895, April 9. Dawkins, Wm. Boyd, M.A., F.R.S., Professor of Geology. *Owens College, Manchester.*

1894, Mar. 6. Delépine, Sheridan, M.D., Professor of Pathology. *Owens College, Manchester.*

1879, Mar. 18. Dent, Hastings Charles, F.L.S., F.R.G.S. 20, *Thurloe Square, South Kensington, London, S W.*

Date of Election.

1887, Feb. 8. Dixon, Harold Bailey, M.A., F.R.S., Professor of Chemistry. *Owens College, Manchester.*

1898, Oct. 18. Donovan, E. W., M.Inst.M.E. *Hilton House, Prestwich, Lancs.*

1899, April 11. Earle, Hardman A. 40, *Oughton Road, Birkdale, Lancs.*

1883, Oct. 2. Faraday, F. J., F.L.S., F.S.S. *Ramsay Lodge, Slade Lane, Levenshulme, Manchester.*

1897, Oct. 19. Faraday, Wilfred B., LL.B. *Ramsay Lodge, Slade Lane, Levenshulme, Manchester.*

1895, April 30. Flux, A. W., M.A., Jevons Professor of Political Economy. 57, *Parsonage Road, Withington, Manchester.*

1897, Nov. 30. Freston, H. W. 6, *St. Paul's Road, Kersal, Manchester.*

1898, Nov. 29. Gamble, F. W., M.Sc. *Owens College, Manchester.*

1886, Feb. 9. Gee, W. W. Haldane, B.Sc. *Technical School, Princess Street, Manchester.*

1896, Nov. 17. Gordon, Rev. Alexander, M.A. *Memorial Hall, Albert Square, Manchester.*

1881, Nov. 1. Greg, Arthur. *Eagley, near Bolton.*

1897, Jan. 26. Grossmann, J., Ph.D. *Harpurhey Chemical Works, Harpurhey, Manchester.*

1875, Feb. 9. Gwyther, Reginald F., M.A., Fielden Lecturer in Mathematics. *Owens College, Manchester.*

1890, Feb. 18. Harker, Thomas. *Brook House, Fallowfield, Manchester.*

1895, Nov. 12. Hartog, Philippe Joseph, B.Sc.. F.C.S., Demonstrator in Chemistry. *Owens College, Manchester.*

1890, Nov. 4. Heenan, H., M.Inst.C.E., M.Inst.M.E. *Manor House, Wilmslow Park, Wilmslow, Cheshire.*

1890, Mar. 4. Henderson, H. A. *Eastbourne House, Chorlton Road, Manchester.*

1889, Jan. 8. Heywood, Charles J. *Chaseley, Pendleton, Manchester.*

1895, Mar. 5. Hickson, S. J., M.A., D.Sc., F.R.S., Professor of Zoology. *Owens College, Manchester.*

1884, Jan. 8. Hodgkinson, Alexander, M.B., B.Sc. 18, *St. John Street, Manchester.*

1898, Nov. 29. Hopkinson, Alfred, Q.C., M.A., Principal of Owens College. *Fairfield, Victoria Park, Manchester.*

1896, Nov. 3. Hopkinson, Edward, D.Sc., M.Inst.C.E. *Oakleigh, Timperley, Cheshire.*

1889, Oct. 15. Hoyle, William Evans, M.A., F.R.S.E., Keeper of the Manchester Museum. *Owens College, Manchester.*

Date of Election.

1896, Nov. 17. Jacob Edwin. 64B, *Hamilton Terrace, London, N.W.*

1870, Nov. 1. Johnson, William H., B.Sc. 26, *Lever Street, Manchester.*

1896, Oct. 20. Jones, A. Emrys, M.D. 10, *St. John Street, Manchester.*

1878, Nov. 26. Jones, Francis, F.R.S.E., F.C.S. *Manchester Grammar School.*

1891, Nov. 17. Joyce, Samuel, Electrical Engineer. *Latchford House, Greenheys Lane, Manchester.*

1886, Jan. 12. Kay, Thomas. *Moorfield, Stockport, Cheshire.*

1891, Dec. 1. King, John Edward, M.A., High Master, *Manchester Grammar School.*

1895, Nov. 12. Kirkman, W. W. *The Grange, Timperley, Cheshire.*

1893, Nov. 14. Lamb, Horace, M.A., F.R.S., Professor of Mathematics. 6, *Wilbraham Road, Fallowfield, Manchester.*

1890, Nov. 4. Langdon, Maurice Julius, Ph.D. 15, *Dickinson Street, Manchester.*

1899, Feb. 7. Lawrence, W. T., B.A., Ph.D. *Owens College, Manchester.*

1884, April 15. Leech, Daniel John, M.D., Professor of Materia Medica. *Owens College, Manchester.*

1895, Nov. 12. Lees, Charles Herbert, D.Sc., Demonstrator in Physics. *Owens College, Manchester.*

1895, Mar. 5. Levenstein, Ivan. *Wilbraham Road, Fallowfield, Manchester.*

1857, Jan. 27. Longridge, Robert Bewick, M.Inst.M.E. *Yew Tree House, Tabley, Knutsford, Cheshire.*

1896, Nov. 3. Lynde, James Henry, M.Inst.C.E. *Buckland, Ashton-on-Mersey, Cheshire.*

1898, Nov. 29. McConnel, J. W., M.A. *Wellbank, Prestwich, Lancs.*

1866, Nov. 13. McDougall, Arthur, B.Sc. *Fallowfield House, Fallowfield, Manchester.*

1859, Jan. 25. Maclure, Sir John William, Bart, M.P., F.R.G.S. *Whalley Range, Manchester.*

1875, Jan. 26. Mann, J. Dixon, M.D., F.R.C.P. (Lond.), Professor of Medical Jurisprudence at Owens College. 16, *St. John Street, Manchester.*

1896, Oct. 20. Massey, Leonard F. *Openshaw, Manchester.*

1864, Nov. 1. Mather William, M.Inst.C.E., M.Inst.M.E. *Iron Works, Salford.*

1873, Mar. 18. Melvill, James Cosmo, M.A., F.L.S. *Brook House, Prestwich, Lancs.*

1896, Nov. 3. Milligan, William, M.D. *Westbourne, Wilmslow Road, Rusholme, Manchester.*

Date of Election.	
1881, Oct. 18.	Mond, Ludwig, Ph.D., F.R.S., V.P.C.S. *Winnington Hall, Northwich, Cheshire.*
1894, Feb. 6.	Mond, Robert, M.A., F.C.S. *Winnington Hall, Northwich, Cheshire.*
1899, Mar. 7.	Morris, Edgar F., B.A. 69, *Shrewsbury Street, Old Trafford, Manchester.*
1873, Mar. 4.	Nicholson, Francis, F.Z.S. 84, *Major Street, Manchester.*
1889, April 16.	Norbury, George. *Hillside, Prestwich Park, Prestwich, Lancs.*
1862, Dec. 30.	Ogden, Samuel. 10, *Mosley Street West, Manchester.*
1884, April 15.	Okell, Samuel, F.R.A.S. *Overley, Langham Road, Bowdon, Cheshire.*
1876, Nov. 28.	Parry, Thomas, F.S.S. *Grafton House, Ashton-under-Lyne.*
1895, Nov. 12.	Pennington, James Dixon, B.A., M.Sc. 254, *Oxford Road, Manchester.*
1892, Nov. 15.	Perkin, W. H., jun., Ph.D., F.R.S., Professor of Organic Chemistry. *Owens College, Manchester.*
1885, Nov. 17.	Phillips, Henry Harcourt, F.C.S. 183, *Moss Lane East, Manchester.*
1888, Feb. 21.	Rée, Alfred, Ph.D., F.C.S. *Guildhall Chambers, Lloyd Street, Manchester.*
1869, Nov. 16.	Reynolds, Osborne, LL.D., M.A., F.R.S., M.Inst.C.E., Professor of Engineering, Owens College. 19, *Ladybarn Road, Fallowfield, Manchester.*
1880, Mar. 23.	Roberts, D. Lloyd, M.D., F.R.S E., F.R.C.P. (Lond.). *Ravenswood, Broughton Park, Manchester.*
1864, Dec. 27.	Robinson, John, M.Inst.C.E., M.Inst.M.E. *Westwood Hall, Leek, Staffs.*
1897, Oct. 19.	Rothwell, William Thomas. *Heath Brewery, Newton Heath, near Manchester.*
1893, Mar. 21.	Schill, C. H. 117, *Portland Street, Manchester.*
1896, Nov. 17.	Schmitz, Hermann Emil, B.A., B.Sc. *Manchester Grammar School.*
1842, Jan. 25.	Schunck, Edward, Ph.D., F.R.S., F.C.S. *Kersal, Manchester.*
1873, Nov. 18.	Schuster, Arthur, Ph.D., F.R.S., F.R.A.S., Professor of Physics. *Owens College, Manchester.*
1898, Jan. 25.	Schwabe, Louis. *Hart Hill, Eccles Old Road, Pendleton, Manchester.*

Date of Election.	
1895, Nov. 12.	Shearer, Arthur. 36, *Demesne Road, Alexandra Park, Manchester.*
1890, Nov. 4.	Sidebotham, Edward John. *Erlesdene, Bowdon, Cheshire.*
1890, Jan. 21.	Sidebotham, James Nasmyth, Assoc.M.Inst.C.E. *Parkfield, Groby Place, Altrincham, Cheshire.*
1886, April 6.	Simon, Henry, M.Inst.C.E., M.Inst.M.E., *Lawnhurst, Didsbury, Manchester.*
1895, Nov. 12.	Southern, Frank, B.Sc. *Burnage Lodge, Levenshulme, Manchester.*
1896, Feb. 18.	Spence, David. *Pine Ridge, Buxton.*
1896, April 14.	Stanton, Thomas E., M.Sc. *University College, Liverpool.*
1894, Jan. 9.	Stevens, Marshall, F.S.S. *Bolton Lodge, Eccles, Lancs.*
1894, Nov. 13.	Stirrup, Mark, F.G.S. *High Thorn, Stamford Road, Bowdon, Cheshire.*
1897, Nov. 30.	Stromeyer, C. E., M.Inst.C.E. *Steam Users' Association,* 9, *Mount Street, Albert Square, Manchester.*
1892, Nov. 29.	Swindells, Rupert, M.Inst.C.E. *Wilton Villa, The Firs, Bowdon, Cheshire.*
1895, April 9.	Tatton, Reginald A., Engineer to the Mersey and Irwell Joint Committee. 44, *Mosley Street, Manchester.*
1898, Feb. 8.	Taylor, Rev. Arthur, M.A. 49, *Egerton Road, Withington, Manchester.*
1893, Nov. 14.	Taylor, R. L., F.C.S., F.I.C. *Central School, Whitworth Street, Manchester.*
1873, April 15.	Thomson William, F.R.S.E., F.C.S., F.I.C. *Royal Institution, Manchester.*
1896, Jan. 21.	Thorburn, William, M.D., B.Sc. 2, *St. Peter's Square, Manchester.*
1889, April 30.	Thornber, Harry. *Rookfield Avenue, Sale, Cheshire.*
1896, Jan. 21.	Thorp, Thomas. *Moss Bank, Whitefield, near Manchester.*
1897, Jan. 26.	Tristram, James Floyd, M.A., B.Sc. 180, *Princess Road, Moss Side, Manchester.*
1879, Dec. 30.	Ward, Thomas. *Wadebrook House, Northwich, Cheshire.*
1873, Nov. 18.	Waters, Arthur William, F.G.S. *Sunny Léa, Davos Dorf, Switzerland.*
1892, Nov. 15.	Weiss, F. Ernest, B.Sc., F.L.S., Professor of Botany, Owens College. 4, *Clifton Avenue, Fallowfield, Manchester.*
1895, April 9.	Whitehead, James. *Lindfield, Fulshaw Park, Wilmslow, Cheshire.*
1859, Jan. 25.	Wilde, Henry, F.R.S. *The Hurst, Alderley Edge, Cheshire.*

Date of Election.	
1899, Feb. 7.	Wilkins, A. S., M.A., Litt.D., LL.D., Professor of Latin. *Owens College, Manchester.*
1859, April 19.	Wilkinson, Thomas Read. *Vale Bank, Knutsford, Cheshire.*
1888, April 17.	Williams, Sir E. Leader, M.Inst.C.E., M.Inst.M.E. *Spring Gardens, Manchester.*
1896, Dec. 1.	Wilson, George, M.Sc. *Owens College, Manchester.*
1889, April 16.	Wilson, Thomas B. *Mellor, near Marple, Cheshire.*
1860, April 17.	Woolley, George Stephen. *Victoria Bridge, Salford.*
1896, Jan. 21.	Wordingham, Charles Henry, A.M.Inst.C.E., M.Inst.M.E. *Hazelhurst, Urmston Lane, Stretford, Manchester.*
1863, Nov. 17.	Worthington, Samuel Barton, M.Inst.C.E., M.Inst.M.E. *Mill Bank, Bowdon,* and 37, *Princess Street, Manchester*
1865, Feb. 21.	Worthington, Thomas, F.R.I.B.A. 46, *Brown Street, Manchester.*
1895, Jan. 8.	Worthington, Wm. Barton, B.Sc., M.Inst.C.E. 2, *Wilton Polygon, Cheetham Hill, Manchester.*
1897, Oct. 19.	Wyatt, Charles H. *Chelford, Cheshire.*

N.B.—Of the above list the following have compounded for their subscriptions, and are therefore life members :—

Bailey, Charles, F.L.S.
Bradley, Nathaniel, F.C.S.
Brogden, Henry, F.G.S.
Johnson, William H., B.Sc.
Worthington, Wm. Barton, B.Sc.

HONORARY MEMBERS.

Date of Election.	
1892, April 26.	Abney, W. de Wiveleslie, Capt. R.E., C.B., F.R.S. *Rathmore Lodge, Bolton Gardens South, S. Kensington, London, S.W.*
1892, April 26.	Amagat, E. H., For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Honorary Professor, Faculté des Sciences, Lyon. 34, *Rue St. Lambert, Paris.*
1894, April 17.	Appell, Paul, Membre de l'Institut, Professor of Theoretical Mechanics, Faculté des Sciences. *Paris.*
1887, April 19.	Armstrong, Wm. George, Lord, C.B., D.C.L., LL.D., F.R.S. *Newcastle-on-Tyne.*
1892, April 26.	Ascherson, Paul F. Aug., Professor of Botany. *Universität, Berlin.*
1892, April 26.	Baeyer, Adolf von, For. Mem. R.S., Professor of Chemistry. 1, *Arcisstrasse, Munich.*
1886, Feb. 9.	Baker, Sir Benjamin, K.C.M.G., LL.D., F.R.S. 2, *Queen's Square Place, Westminster, S.W.*
1886, Feb. 9.	Baker, John Gilbert, F.R.S., F.L.S. *Royal Herbarium, Kew.*
1895, April 30.	Beilstein, F., Ph.D., Professor of Chemistry. *8th Line, N. 17, St. Petersburg, W.O.*
1886, Feb. 9.	Berthelot, Marcellin, For. Mem. R.S., Membre de l'Institut, Professor of Chemistry. *Paris.*
1892, April 26.	Boltzmann, Ludwig, Professor of Physics. *K. K. Universität, Vienna.*
1886, Feb. 9.	Buchan, Alexander, M.A., LL.D., F.R.S., F.R.S.E. 42, *Heriot Row, Edinburgh.*
1860, April 17.	Bunsen, Robert Wilhelm, Ph.D., For. Mem. R.S., For. Assoc. Inst. Fr. (Acad. Sci.), Professor of Chemistry. *Universität, Heidelberg.*
1888, April 17.	Cannizzaro, Stanislao, For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Chemistry. *Reale Università, Rome.*
1889, April 30.	Carruthers, William, F.R.S., F.L.S. 14, *Vermont Road, Norwood, London, S.E.*
1866, Oct. 30.	Clifton, Robert Bellamy, M.A., F.R.S., F.R.A.S., Prof of Experimental Philosophy. *New Museum, Oxford.*

Date of Election.	
1887, April 19.	Cornu, Marie Alfred, For. Mem. R.S., Membre de l'Institut, Professor of Physics. *École Polytechnique, Paris.*
1892, April 26.	Curtius, Theodor, Professor of Chemistry. *Universität, Kiel.*
1892, April 26.	Darboux, Gaston, Membre de l'Institut, Professor of Geometry, Faculté des Sciences. 36, *Rue Gay Lussac, Paris.*
1886, Feb. 9.	Dawson, Sir John William, C.M.G., M.A., LL.D., F.R.S., F.G.S. *McGill College, Montreal.*
1894, April 17.	Debus, H., Ph.D., F.R.S. 4, *Schlangenweg, Cassel, Hessen, Germany.*
1888, April 17.	Dewalque, Gustave, Professor of Geology. *Université, Liége.*
1892, April 26.	Dohrn, Dr. Anton. *Zoological Station, Naples.*
1892, April 26.	Dyer, Sir W. T. Thiselton, K.C.M.G., C.I.E., M.A., F.R.S., Director of the Royal Botanic Gardens. *Kew.*
1892, April 26.	Edison, Thomas Alva. *Orange, N.J., U.S.A.*
1895, April 30.	Elster, Julius, Ph.D. 6, *Lessingstrasse, Wolfenbüttel.*
1889, April 30.	Farlow, W. G., Professor of Botany. *Harvard College, Cambridge, Mass., U.S.A.*
1889, April 30.	Flower, Sir William Henry, K.C.B., LL.D., F.R.S., Corr. Memb. Inst. Fr. (Acad. Sci.). 26, *Stanhope Gardens, South Kensington, London, S. W.*
1889, April 30.	Foster, Michael, M.A., M.D., LL.D., Sec. R.S., Professor of Physiology. *Trinity College, Cambridge.*
1860, April 6.	Frankland, Sir Edward, K.C.B., Ph.D., M.D., LL.D., D.C.L., F.R.S., V.P.C.S., For. Assoc. Inst. Fr. (Acad. Sci.) *The Yews, Reigate Hill, Reigate, Surrey.*
1892, April 26.	Friedel, Ch., D.C.L., Membre de l'Institut, Professor of Organic Chemistry, Faculté des Sciences. 9, *Rue Michelet, Paris.*
1892, April 26.	Fürbringer, Max, Professor of Anatomy. *Grossherz. Universität, Jena.*
1892, April 26.	Gegenbaur, Carl, For. Mem. R.S., Professor of Anatomy. 57, *Leopoldstrasse, Heidelberg.*
1895, April 30.	Geitel, Hans. 6, *Lessingstrasse, Wolfenbüttel.*
1892, April 26.	Gibbs, J. Willard, For. Mem. R.S., Professor of Mathematical Physics. *Yale University, Newhaven, Connecticut, U.S.A.*

Date of Election.	
1894, April 17.	Glaisher, J. W. L., Sc.D., F.R.S., Lecturer in Mathematics. *Trinity College, Cambridge.*
1894, April 17.	Gouy, A., Professor of Physics, Faculté des Sciences. *Lyons.*
1894, April 17.	Guldberg, Cato M., Professor of Applied Mathematics. *Christiania, Norway.*
1894, April 17.	Harcourt, A. G. Vernon, M.A., D.C.L., F.R.S., Lee's Reader in Chemistry, Christ Church. *Cowley Grange, Oxford.*
1894, April 17.	Heaviside, Oliver, F.R.S. *Bradley View, Newton Abbot, Devon.*
1892, April 26.	Hermite, Ch., LL.D. (Edin.), For. Mem. R.S., Membre de l'Institut. 2, *Rue de la Sorbonne, Paris.*
1892, April 26.	Hill, G. W. *West Nyack, N. Y., U.S.A.*
1888, April 17.	Hittorf, Johann Wilhelm, Professor of Physics. *Polytechnicum, Münster.*
1892, April 26.	Hoff, J. van't, Ph.D., For. Mem. R.S., Professor of Chemistry. 2, *Uhlandstrasse, Charlottenburg, Berlin.*
1892, April 26.	Hooker, Sir Joseph Dalton, G.C.S.I., C.B., D.C.L., F.R.S., Corr. Memb. Inst. Fr. (Acad. Sci.). *The Camp, Sunningdale, Berks.*
1869. Jan. 12.	Huggins, Sir William, K.C.B., LL.D., D.C.L., F.R.S., F.R.A.S., Corr. Memb. Inst. Fr. (Acad. Sci.). 90, *Upper Tulse Hill, Brixton, London, S. W.*
1851, April 29.	Kelvin, William Thomson, Lord, G.C.V.O., M.A., D.C.L., L.L.D., F.R.S., F.R.S.E., For. Assoc. Inst. Fr. (Acad. Sci.), Professor of Natural Philosophy. 2, *College, Glasgow.*
1892, April 26.	Klein, Felix, Ph.D., For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Mathematics. 3, *Wilhelm Weber Strasse, Göttingen.*
1894, April 17.	Königsberger, Leo, Professor of Mathematics. *Universität, Heidelberg.*
1895, April 30.	Lacaze-Duthiers, F. J. Henri de, For. Mem. R.S., Membre de l'Institut, Professor of Zoology and Comparative Anatomy, 7, *Rue de l'Estrapade, Paris.*
1892, April 26.	Ladenburg, A., Ph.D., Professor of Chemistry. 3, *Kaiser Wilhelm Strasse, Breslau.*
1887, April 19.	Langley, S. P., For. Mem. R.S. *Smithsonian Institution, Washington, U.S.A.*
1892, April 26.	Liebermann, C., Professor of Chemistry. 29, *Matthäi-Kirch Strasse, Berlin.*

Date of Election.

1887, April 19. Lockyer, Sir J. Norman, K.C.B., F.R.S., Corr. Memb. Inst. Fr. (Acad. Sci.). *Royal College of Science, South Kensington, London, S. W.*

1889, April 30. Lubbock, Sir John, Bart., M.P., D.C.L., LL.D., F.R.S. 15, *Lombard Street, London, E.C.*

1892, April 26. Marshall, Alfred, M.A., Professor of Political Economy. *Balliol Croft, Madingley Road, Cambridge.*

1892, April 26. Mascart, E. E. N., For. Mem. R.S., Membre de l'Institut, Professor at the Collège de France. 176, *Rue de l'Université, Paris.*

1889, April 30. Mendeléeff, D., Ph.D., For. Mem. R.S., *Université, St. Petersburg.*

1895, April 30. Mittag-Leffler, Gösta, D.C.L. (Oxon.), For. Mem. R.S., Professor of Mathematics. *Djursholm, Stockholm.*

1892, April 26. Moissan, H., Membre de l'Institut, Professor at the École Supérieure de Pharmacie. 7, *Rue Vauquelin, Paris.*

1894, April 17. Murray, Sir John, K.C.B., LL.D., D.Sc., F.R.S. *Challenger Lodge, Wardie, Edinburgh.*

1894, April 17. Neumayer, Professor G., Director of the Seewarte. *Hamburg.*

1887, April 19. Newcomb, Simon, For. Mem. R.S., For. Assoc. Inst. Fr. (Acad. Sci.), Professor of Mathematics and Astronomy. *Johns Hopkins University, Baltimore, U.S.A.*

1894, April 17. Ostwald, W., Professor of Chemistry. 2/3, *Linnéstrasse, Leipsic.*

1899, April 25. Palgrave, R. H. Inglis, F.R.S., F.S.S. *Belton, Great Yarmouth.*

1892, April 26. Perkin, W. H., LL.D., Ph.D., F.R.S. *The Chestnuts, Sudbury, Harrow.*

1894, April 17. Pfeffer, Wilhelm, For. Mem. R.S., Professor of Botany. *Botanisches Institut, Leipsic.*

1892, April 26. Poincaré, H., For. Mem. R.S., Membre de l'Institut, Professor of Astronomy. 63, *Rue Claude Bernard, Paris.*

1892, April 26. Quincke, G. H., For. Mem. R.S., Professor of Physics. *Universität, Heidelberg.*

1899, April 25. Ramsay, William, Ph.D., F.R.S., Professor of Chemistry. 12, *Arundel Gardens, Notting Hill, London, W.*

Date of Election	
1892, April 26.	Raoult, F. M., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Chemistry. 2, *Rue des Alpes, Grenoble.*
1849, Jan. 23.	Rawson, Robert, F.R.A.S. *Havant, Hants.*
1886, Feb. 9.	Rayleigh, John William Strutt, Lord, M.A., D.C.L. (Oxon.), LL.D. (Univ. McGill), F.R.S., F.R.A.S. Corr. Memb. Inst. Fr. (Acad. Sci.). *Terling Place, Witham, Essex.*
1897, April 27.	Roscoe, Sir Henry Enfield, B.A., LL.D., D.C.L., F.R.S., V.P.C.S., Corr. Memb. Inst. Fr. (Acad. Sci.). 10, *Bramham Gardens, South Kensington, London, S. W.*
1889, April 30.	Routh, Edward John, D.Sc., F.R.S. *Newnham Cottage, Queen's Road, Cambridge.*
1894, April 17.	Rowland, Henry A., For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Physics. *Johns Hopkins University, Baltimore, U.S.A.*
1889, April 30.	Salmon, Rev. George, D.D., D.C.L., LL.D., F.R.S., Corr. Memb. Inst. Fr. (Acad. Sci.) *Provost's House, Trinity College, Dublin.*
1894, April 17.	Sanderson, J. S. Burdon, M.A., M.D., F.R.S., Regius Professor of Medicine. *University, Oxford.*
1892, April 26.	Sharpe, R. Bowdler, LL.D., F.L.S., F.Z.S. *British Museum (Natural History), Cromwell Road, London, S. W.*
1892, April 26.	Solms, H. Graf zu, Professor of Botany. *Universität, Strassburg.*
1869, Dec. 14.	Sorby, Henry Clifton, LL.D., F.R.S., F.L.S., F.G.S. *Broomfield, Sheffield.*
1851, April 29.	Stokes, Sir George Gabriel, Bart., M.A., LL.D., D.C.L., F.R.S., Corr. Mem. Inst. Fr. (Acad. Sci.), Lucasian Professor of Mathematics. *Lensfield Cottage, Cambridge.*
1886, Feb. 9.	Strasburger, Eduard, D.C.L., For. Mem. R.S., Professor of Botany. *Universität, Bonn.*
1895, April 30.	Suess, Eduard, Ph.D., For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Geology. 9, *Africanergasse, Vienna.*
1868, April 28.	Tait, Peter Guthrie, M.A., F.R.S.E., Professor of Natura Philosophy. 38, *George Square, Edinburgh.*
1895, April 30.	Thomson, Joseph John, M.A., Sc.D., F.R.S., Professor of Experimental Physics. 6, *Scrope Terrace, Cambridge.*
1894, April 17.	Thorpe, T. E., Ph.D., D.Sc., LL.D., F.R.S. *Laboratory, Somerset House, London, W.C.*
1894, April 17.	Turner, Sir William, M.B., D.C.L., F.R.S., F.R.S.E., Professor of Anatomy. 6, *Eton Terrace, Edinburgh.*

Date of Election.	
1886, Feb. 9.	Tylor, Edward Burnett, D.C.L. (Oxon.), LL.D. (St. And. and McGill Colls.), F.R.S., Professor of Anthropology. *Museum House, Oxford.*
1894, April 17.	Vines, Sidney Howard, M.A., D.Sc., F.R.S., Sherardian Professor of Botany. *Headington Hill, Oxford.*
1894, April 17.	Waage, P., Professor of Chemistry. *Christiania, Norway.*
1894, April 17.	Warburg, Emil, Professor of Physics. *Physikalisches Institut, Neue Wilhelmstrasse, Berlin.*
1894, April 17.	Ward, H. Marshall, D.Sc., F.R.S., Professor of Botany. *Botanical Laboratory, New Museums, Cambridge.*
1894, April 17.	Weismann, August, Professor of Zoology. *Universität, Freiburg i. Br.*
1889, April 30.	Williamson, Alexander William, Ph.D., LL.D., F.R.S., V.P.C.S., Corr. Mem. Inst. Fr. (Acad. Sci.) *High Pitfold, Shottermill, Haslemere, Surrey.*
1886, Feb. 9.	Young, Charles Augustus, Professor of Astronomy. *Princeton College, N.J., U.S.A.*
1888, April 17.	Zirkel, Ferdinand, For. Mem. R.S., Professor of Mineralogy. *Thalstrasse, 33, Leipsic.*
1895, April 20.	Zittel, Carl Alfred von, Professor of Palæontology and Geology. *Universität, Munich.*

CORRESPONDING MEMBERS.

Date of Election.	
1866, Jan. 23.	De Caligny, Anatole, Marquis, Corr. Mem. Accad. Sci. Turin, Soc. Agr. Lyons, Soc. Sci. Cherbourg. *Liége.*
1850, April 30.	Harley, Rev. Robert, Hon. M.A. (Oxon.), F.R.S., F.R.A.S., Hon. M.R.S. Queensland. *Rosslyn, Westbourne Road, Forest Hill, London, S.E.*, and *The Athenæum Club, London, S.W.*
1882, Nov. 14.	Herford, Rev. Brooke, D.D., 91, *Fitzjohn's Avenue, Hampstead, London, N.W.*
1859, Jan. 25.	Le Jolis, Auguste-François, Ph.D., Archiviste-perpétuel and late President of the Soc. Nat. Sci. Cherbourg. *Cherbourg.*
1857, Jan. 27.	Lowe, Edward Joseph, F.R.S., F.R.A.S., F.R. Met. S., F.G.S. *Shirenewton Hall, near Chepstow, Monmouthshire.*

Awards of the Wilde Medal under the conditions of the Wilde Endowment Fund.

1896. Sir GEORGE G. STOKES, Bart., F.R.S.

1897. Sir WILLIAM HUGGINS, K.C.B., F.R.S.

1898. Sir JOSEPH DALTON HOOKER, G.C.S.I., C.B., F.R.S.

1899. SIR EDWARD FRANKLAND, K.C.B., F.R.S.

Award of the Dalton Medal.

1898. EDWARD SCHUNCK, Ph.D., F.R.S.

Awards of the Premium under the conditions of the Wilde Endowment Fund.

1897. PETER CAMERON.

1898. JOHN BUTTERWORTH, F.R.M.S.

1899. CHARLES H. LEES, D.Sc.
